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ABSTRACT

This interdisciplinary curriculum provides students with the opportunity to learn about the connection between natural resources and buildings while practicing skills in language arts, math, science, social studies, and visual arts. The learning activities are divided by topic into 15 Building Blocks (units). These units cover such topics as architectural elements, building materials, housing around the world, local resources, energy, forces of nature, and population and development. Emphasis is placed on resource efficiency through examination of recyclable materials, efficiency of design, toxins and other pollutants, and renewable energy. Each block consists of: (1) an overview for the instructor which states the goals and objectives for the unit as well as suggested materials and an overview of student activities; (2) the activities which list questions for students to explore, topics for class discussion, and suggestions for projects that students can do; and (3) resource notes which provide the instructor with background information and offer listings of some resources for further research. The curriculum guide contains a scope and sequence guide, a description of themes by discipline, learner outcomes, and an evaluation form. A building material design contest is also included as an option for students. (PVD)

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ED 422 178

Building Our Children's Future

An interdisciplinary curriculum for grades K-12

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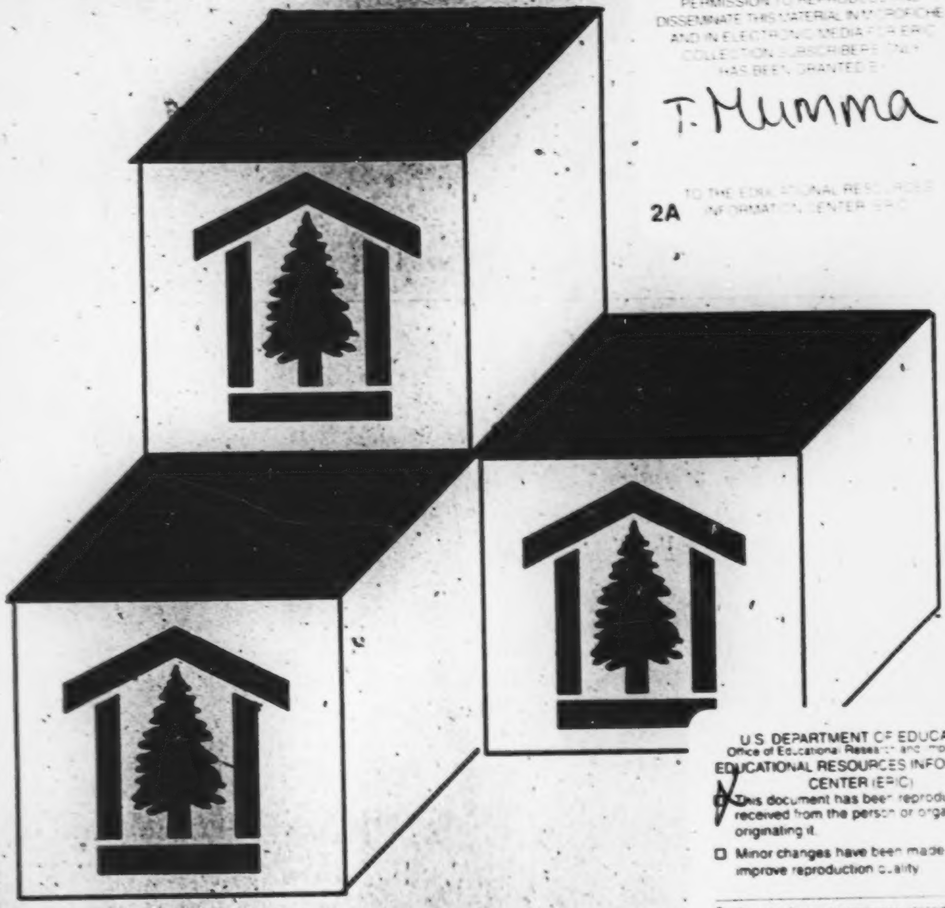

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Center for Resourceful Building Technology

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Notes to Instructors

In keeping with the theme of resource efficiency presented in this curriculum, we ask you to salvage and reuse a three-ring binder to hold these pages. A cover sheet is provided for your convenience.

This is an interdisciplinary curriculum that provides the opportunity for students to practice and master skills in language arts, math, science, social studies and visual arts while learning about the connection between natural resources and buildings. The subject matter is divided by topic into "blocks," and each block includes a number of related activities. Instructors may feel free to select particular blocks and activities within those blocks that are most relevant to the subject matter and skill level of the class. Each block consists of an Overview for the instructor, that states the goals and objectives for the unit, as well as suggested materials and an overview of activities, with ideas for student evaluation. Next, the Activities section lists questions for students to explore, topics for class discussion, and suggestions for projects students can do. Finally, the Resource Notes section of each block provides the instructor with background information, and offers listings of some resources for further research, should the class or an individual student wish to pursue the topic in greater depth, or examine related issues.

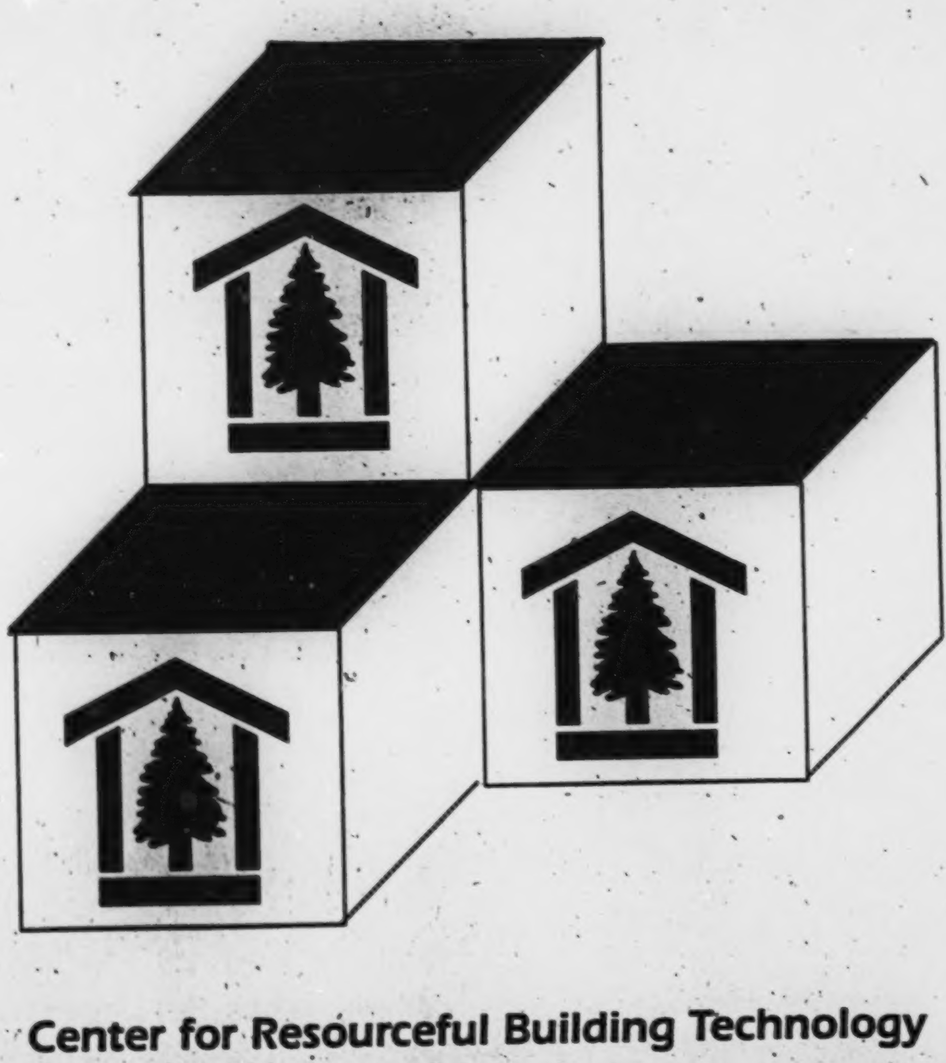
The activities listed in this curriculum are adaptable to a wide range of ages. Activities which apply best to certain age groups are designated within the activity sections. Activities that are not designated for a particular age group can be easily adapted for use by a range of ages. Older students will be able to delve into activities in more depth and perhaps do additional research on the topics. Younger students can approach topics in a more general sense, to become familiar with the vocabulary and concepts presented in each block. Learner Outcomes are summarized at the end of the curriculum, and may trigger additional ideas for activities, methods, and evaluation of students.

As an assessment tool, and as part of an on-going study of resource efficient building practices for your school and others, it is beneficial for teachers to keep a classroom portfolio of research and conclusions made by the class. Students may create new ways of coping with the increasing demand upon our forests and lands to build new homes and other buildings. These ideas should be developed and shared as part of this curriculum: shared with legislators, construction companies, city government officials, city planning committees, and others. Encourage students to be active agents of change, informed and enlightened recyclers, open and creative problem solvers.

We hope that you enjoy implementing Building our Children's Future. We welcome your feedback on the curriculum and your suggestions for additional blocks to add. We invite the participation of your students in the contests explained within the package. Periodically registered users of this curriculum will receive update packets with additional blocks. We look forward to hearing from you and your students, and thank both you and your students for joining us in building a better future for all of our children.

Building Our Children's Future

An interdisciplinary curriculum for grades K-12



Center for Resourceful Building Technology

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Center for
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Technology

Fostering Efficient Resource Use.

February 1996

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Building Our Children's Future:
An Interdisciplinary Curriculum for Grades K-12

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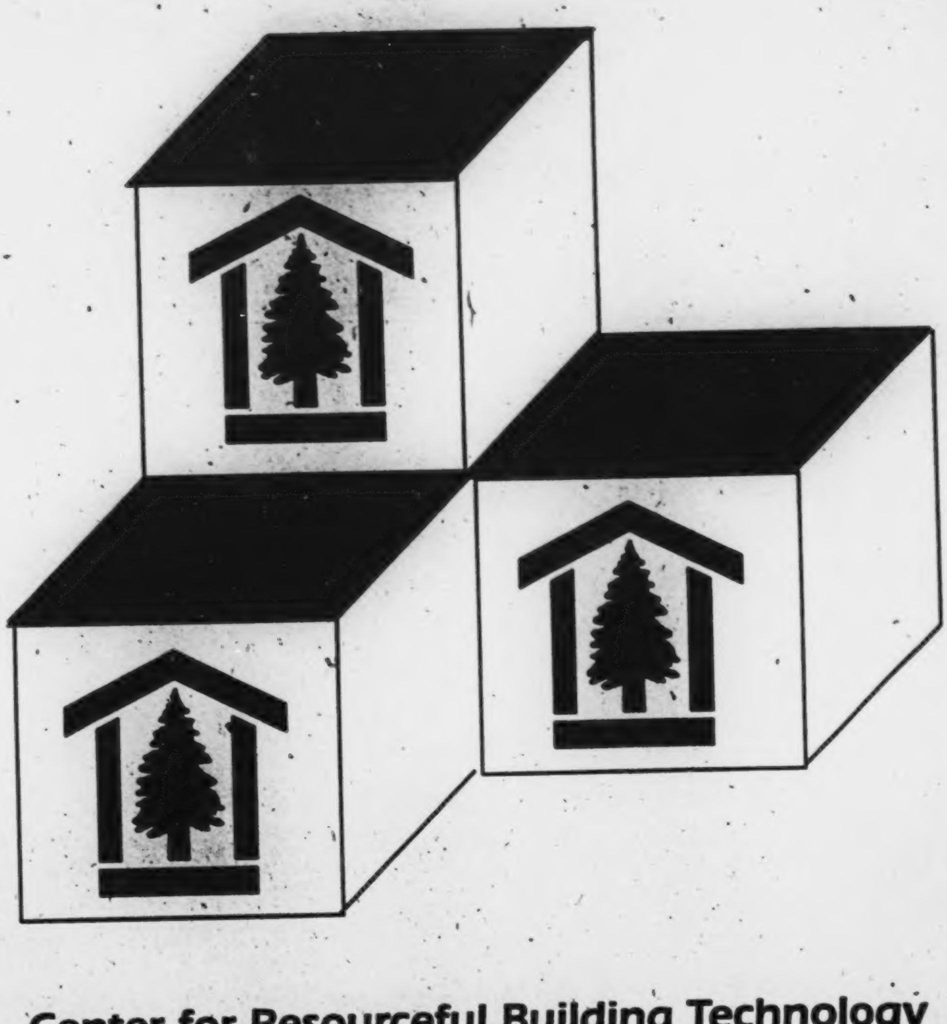
Building Our Children's Future – Evaluation

Building Our Children's Future

Scope and Sequence Guide



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Building Our Children's Future

Scope and Sequence Guide

Grades K-12

Discipline	Level	Concepts Introduced and Developed
Language Arts	K-12	Writing
	K-12	Reading: Non-fiction
	K-12	Listening
	K-12	Speaking
	K-12	Thinking Skills
Math	K-12	Mathematics as Problem Solving
	K-8	Mathematics as Communication
	K-8	Mathematics as Reasoning
	K-8	Mathematics as Connections
	4-12	Geometry
	9-12	Spatial Sense
Social Studies	3-12	Cultural Heritage: Society in Transition
	K-12	Global Perspective: World Cultures
	K-3	Tradition & Change: Environmental Concerns
	2-12	Political & Economic Systems: Natural Resources
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	K-12	Spatial Relationships: Physical Geography: Natural Resources
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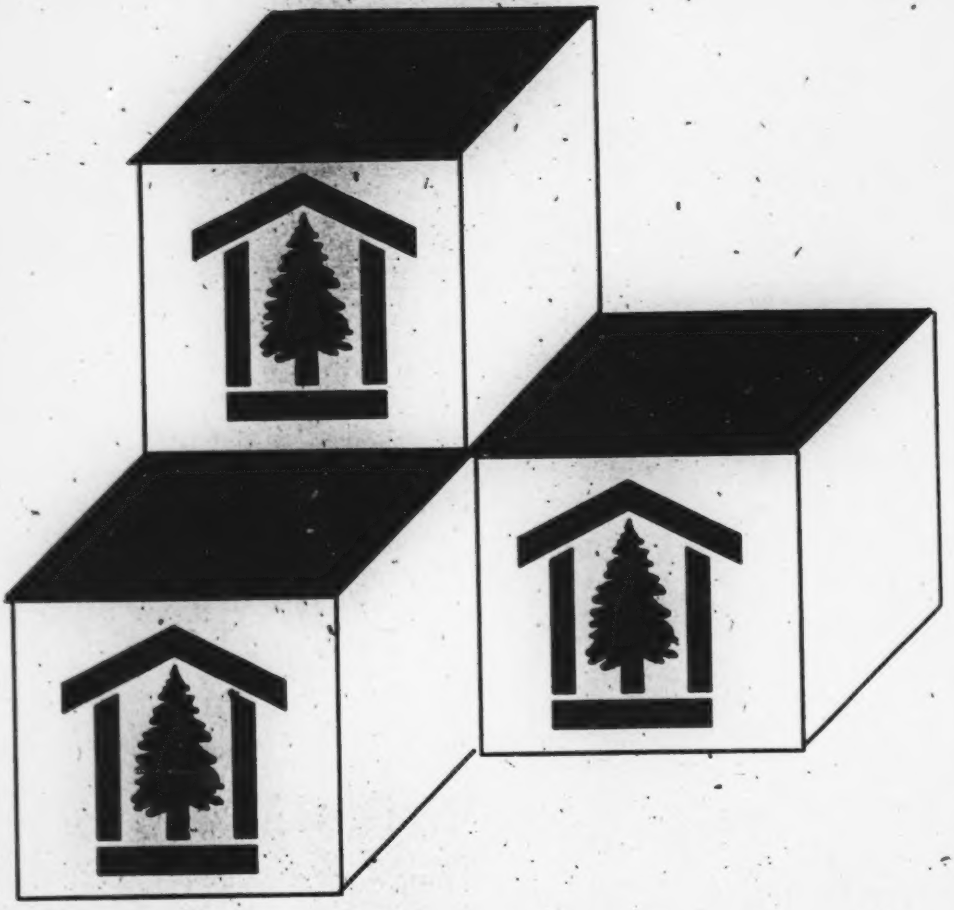
	K-12	Making Art: Creativity, Personal Expression, Basic Skills
	K-12	Valuing: Analysis, Interpretation and Judgment
	K-12	Visual Heritage: Historic Periods, World Cultures, Individual Artists

Building Our Children's Future

Themes



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Building Our Children's Future

Language Arts Themes

Grades K-12

Writing (W)
Writing is a developmental process with specific stages: prewriting, composing, editing, and sharing or publishing. The elements of writing (organization, content, style, vocabulary, and grammar) must be integral parts of the total process. Writing cannot be isolated, and thus can be used as an integrative process for thinking about science, social studies, and math research. Students must write frequently for a variety of audiences and purposes, including documentation, expression and persuasion.

Reading (R)
Non-fiction articles are the primary sources of reading material that will come to the student through this unit, in the presentation of new ideas and research on related topics. Reading activities should include the research skills used to locate and process new information.

Listening (L)
Listening to the written word each day is imperative for K-3 students to develop an ear for language. Older students can listen to each other's ideas, learn to carry on orderly discussions, and take in messages from a variety of speakers. Listening defines personal and cultural values. Many listening activities take place during the evaluation section of each block.

Speaking (S)
Students use a variety of public speaking formats such as group discussion, oral reading, presentations, book reports, and research reports, to communicate on resource conservation topics. Types of speeches should include demonstration, debates, improvisation, extemporaneous, etc.

Thinking Skills (TS)
Critical thinking activities or strategies will help students develop thinking skills such as the ability to see relationships, to categorize, to analyze, to synthesize, to make decisions, and to solve problems. Creative thinking activities or strategies will help students develop **fluency**, the ability to generate many responses for a given problem; **flexibility**, the ability to respond with new uses for familiar objects or situations or with new solutions for familiar problems; **originality**, the ability to generate nontraditional or unexpected ideas and to produce these ideas in unique products and building practices; and **elaboration**, the ability to add details to existing products.

Learner outcomes are coded for each lesson plan in this curriculum according to the above initials to help you quickly identify which language arts themes are covered.

Building Our Children's Future

Mathematics Themes

Grades K-12

Mathematics as Problem Solving (PS)
The study of mathematics should include numerous and varied experiences with problem solving as a method of inquiry and application. Students learn to approach complex problems related to building and the environment, and develop methods of reaching solutions.

Mathematics as Communication (C)
The study of mathematics should include opportunities to communicate. Students are active models in situations using oral, written, concrete, pictorial, graphical, and algebraic methods in solving design, recycling, and building problems and presenting results in an understandable format.

Mathematics as Reasoning (R)
Inductive and deductive reasoning permeate the study of mathematics, enabling students to make, present and evaluate conjectures and arguments. Reasoning is an active process that validates the student's own thinking. Mathematical reasoning provides a basis for comparison and decision making.

Mathematics as Connections (CN)
Students see mathematics as an integrated whole by investigating local, state and world systems. They explore the problems inherent in city planning for growth and conservative use of energy and resources. Connections are made between a mathematical idea and a problem, which leads to further understanding of other mathematical ideas and the role they play in the world around us.

Geometry and Spatial Sense (G)
Students apply geometric properties to solve problems with building design and the construction process, and the restoration of habitat around a building site. They use technology such as graphing calculators, CAD programs and computers to solve problems.

Learner outcomes are coded for each lesson plan in this curriculum according to the above initials to help you quickly identify which mathematics themes are covered.

Building Our Children's Future

Science Themes

Grades K-12

Change (C)
Understanding the way natural and human forces alter the earth over time is key to understanding what impact a single individual can have on the earth. Humans convert natural resources to useful products through a variety of processes. Through the study of plans, buildings, and resource use, we can learn to make efficient choices in the use of transforming processes, to preserve and improve the quality of our habitat.

Equilibrium (E)
Natural systems represent a complex balance of many constituents and forces. Humans must determine their role in these systems and learn to integrate conflicting uses of ecosystems without destroying the homeostasis of nature. Buildings can be designed to have their own equilibrium, patterned after and using natural systems.

Interrelationships (I)
The co-existence of people and nature is a complex relationship that is constantly changing. Climate, population, resources and housing are linked inextricably. Only in affluent times during human history has building been a luxury, not a response to the weather and natural forces. Supplies of resources for human use are limited, and as a society we must be responsible consumers, and recognize our role in the natural world.

Organization (O)
Using map reading skills, applying knowledge, and creating solutions to problems requires an organized mind. Understanding methods and principles of organization promotes efficient use of natural resources and an understanding of the human role in natural systems. Human systems of organization provide the basis for a variety of careers in construction and resource management.

Time/Space (T/S)
The way that people use space and resources changes over time, as populations grow, shrink, and shift. Understanding the causes and results of these changes establishes awareness of the ongoing relationship between humans and our world.

Variation (V)
Climates, habitats and species are all subject to variations. Individuals and societies adapt to different climates and situations in many ways. Recognizing different adaptations and why they occur increases awareness of the environment and the ways that humans respond to it.

Energy/Matter (E/M)
Human and natural processes use energy to alter matter. Understanding the production of energy from matter and the ways that people use energy assists in identifying ways to conserve both energy and resources.

Learner outcomes are coded for each lesson plan in this curriculum according to the above initials to help you quickly identify which science themes are covered.

Building Our Children's Future

Social Studies Themes

Grades K-12

Cultural Heritage (CR)
Historical events have had lasting effects in determining who we are as people and how we build our homes, use energy and resources, and live together in communities. Different cultures base their architecture and resource use on differing histories, principles and social systems.

Global Perspective (GP)
Individual nations of the world are connected through our shared environment. In this curriculum, the focus is the connection made through technologies and environmental problems in our modern world. As a species, we have common needs for shelter, which we create from natural resources available to us. Our common future survival and success involves the use of renewable sources of energy and recycled or alternative building materials and methods, and the reuse of buildings. Learning from the ways other cultures are meeting their challenges provides an opportunity to improve our shared future.

Tradition and Change (TC)
The struggle between traditional ways and new ideas is a constant issue throughout history. This struggle continues today–in fact the rate of change is accelerating. Struggle is natural in a world of competing ideas and ways, new inventions, and new ideas. Necessity is often an agent of change, so are preventive measures such as energy and resource conservation.

Political/Economic (PE)
To become productive members of a society, people must comprehend the political and economic systems under which they live. Through understanding of a system's structure and its function, access becomes possible. Through this access, citizens are empowered to work for change and the common good by utilizing or improving the system.

Social History (SH)
The social history of ordinary people who make contributions to society is emphasized in this curriculum through research of students' personal and city history, and interaction with individuals who have careers and interests dealing with natural resources and the built environment.

Spatial Relationships (SR)
The geography of the earth and human geography are important aspects of defining the shelters we build. Distribution of resources, spatial organization, and use of landscapes and spaces have impacts on our health, the way we think about the world, and the choices we make in our communities. Climate and population growth are spatially related phenomena which dictate resource efficient options for building homes.

Social Contracts (SC)
Social contracts include both informal and formal arrangements as people interact in groups and as responsible citizens of their city, state, nation and the world. By investigating the relationship we have with members of our society, we work toward understanding our own place in the world and our society's place in the environment. Our environment is directly affected by these relationships and the philosophies which govern reusing, recycling and reducing use of building materials.

Learner outcomes are coded for each lesson plan in this curriculum according to the above initials to help you quickly identify which social studies themes are covered.

Building Our Children's Future

Visual Arts Themes

Grades K-12

Aesthetic Perception (AP) Perceiving and Responding to the Environment
A heightened appreciation and sensitivity to diverse art forms in the human and natural environments is an inherent part of all architecture.

Careers (C) Graphic Artists, Crafts people, Architects and Designers, Fine Artists
The development of environmental artists and architects in the traditional arts careers can occur through this introduction to state-of-the-art building ideas. Construction is a skill that integrates art with other disciplines and life.

Making Art (MA) Creativity, Personal Expression, Basic Skills, Architectural Production and Design
It is important to develop the ability to express oneself visually with various media through meaningful and sequential art experiences. The assimilation of techniques and discipline which allow for every person's artistic expression and interpretation of the world, along with the integration of these skills with environmental themes and projects, are potentials in this curriculum.

Valuing (V) Analysis, Interpretation and Judgment
The ability to think resourcefully, creatively, and critically, and express ideas using the vocabulary of design and the visual arts is an important part of beginning any new way of using alternative construction.

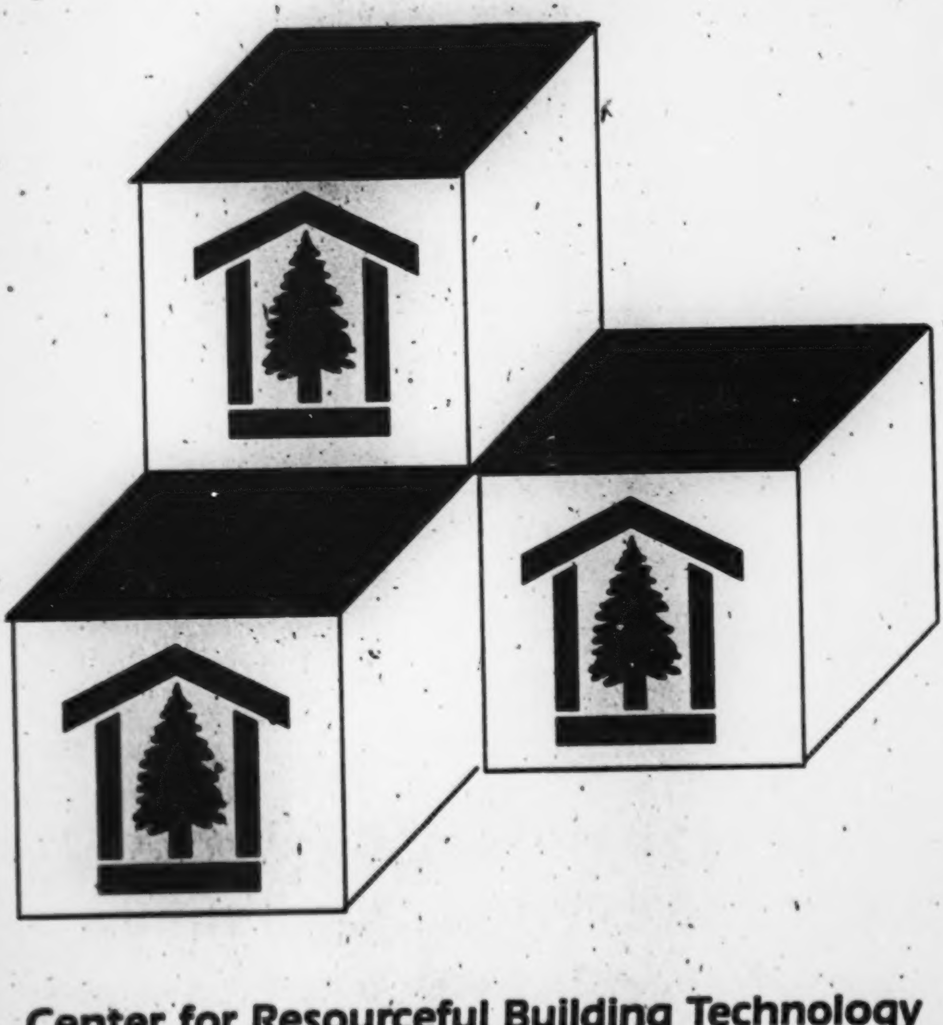
Visual Heritage (VH) Historic Periods, World Cultures, Individual Artists
The cultural and social diversity inherent in the study and production of architecture enhances individuals as creative thinkers, problem solvers, and visionary leaders in the world. Historic buildings provide an important record of the of evolution of art as applied in architecture.

Learner outcomes are coded for each lesson plan in this curriculum according to the above initials to help you quickly identify which visual arts themes are covered.

Building Our Children's Future

Building Blocks

- Overviews
- Activities
- Resource Notes



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Block 1: Building Blocks
Overview

Goal:

1. To provide an overview of the components and systems and design elements which make up buildings.
2. To be aware of which natural resources were used to build your school and home.
3. To provide an introduction to resource efficient building.

Objectives:

1. Outline the natural resources, processes and systems which were used to build our school and homes.
2. View building in new ways: using different materials and different styles.
3. Introduce principles of resource efficiency as it applies to building.

Materials:

- examples or drawings of architectural elements like arches, walls, doors, windows, porches, decks, landscaping, roofs, floors, chimneys (you may want to have the students draw examples of these things from their own knowledge, then save the best for future activities)
- pictures or slides of different types of housing; find examples of various architectural styles (Victorian, Native American, adobe, yurts, mobile homes, brick, sky scrapers, etc.).
- photos or drawings of conventional building materials: brick, lumber, plastics, glass, steel, aluminum, vinyl, wallboard, concrete; photos or drawings of the places where these materials originate; descriptions of the processes which are used to create conventional building materials.
- science texts or wall charts showing diagrams of the human body's systems: skeletal, circulatory, respiratory, excretory, nervous, muscular, endocrine, skin, and circulatory
- meter stick, tape measure, large measuring tape and calculators

Activity Summary:

- Notice design elements involved in building and identify their effects. S (O); VA (AP) (V) (VH)
- Invite an architect to speak to the class about design. LA (L); VA (C)
- Identify the materials used in constructing schools and homes, and connect these materials with the resources used to produce them. LA (S) (TS); S (C) (E/M); SS (SR)
- Further explore the link between resources and building materials by assessing local resources that could supply building materials. LA (TS); S (C) (E/M); SS (SR) (PE)
- Learn more about building materials and their availability by visiting a lumberyard or home center, and writing about the trip. LA (W) (L); SS (PE) (SH)
- Follow the lifecycle pathway of selected building materials and learn how market demands and supplies determine prices and material availability. S (C) (I) (E/M); SS (PE)
- Recognize similarities and differences in housing through comparison between houses, and learn about building systems through comparison with the human body. LA (TS); S (C) (O); SS (TC); VA (AP) (MA) (V)

- Relate construction and math skills in an introduction to square footage, linear feet, wall area and their importance in construction. M (PS) (G)
- Become acquainted with the concept of resource efficiency and associated vocabulary. LA (R); S (I)

Evaluation:

As a Class

- Begin portfolios for this unit by taking notes on discussions about recycling, systems, and building products.
- Keep a list of ideas as a class. Post it where everyone can see it and add to it each day of this unit. Topics can include: Ways to Recycle and Reuse Materials, Examples of Outstanding Buildings.

Individuals

- Research and report on various building materials, their origin, availability and costs, and how to use them in building a home, school, or office building.
- Keep a journal of poems, stories, essays, reactions to speakers, interview results and critiques of ideas throughout the unit.

Block 1: Building Blocks
Activities

What is a building? Most people go in and out of buildings all day without even thinking about what materials those structures are made from. The materials that make up buildings were once trees, sand, rocks and other natural resources. Buildings are more than just what is visible from the outside or inside. Within the walls are many different systems that provide light, heat, and water. Understanding what goes into a building is an important first step in learning to build better buildings.

1 What design elements are present in your school building and other buildings in your town? Here are some examples of elements to look for:

- Symmetry
- Balance
- Repetition
- Variation

How do these design elements combine to provide clues about what a building is used for? Some buildings look formal and official. Others look fun and inviting. How do elements of design affect the look of a building? Elements of design can also be used to make a building blend into its surroundings, or stand out from them. If you were designing a building, how would you make it blend into its site? Invite an architect to speak to your class about elements of design and their uses.

2 Look around your classroom and school building. What materials is it made from? Think about the materials that you may not be able to see–the ones within walls, the roof, and foundation.

3 What natural resources were used to make the materials in your school building? Where did those materials come from? How far did they travel to be installed there?

4 What building materials are manufactured in your town or county? What raw materials are locally available, that could be used to manufacture building materials?

5 Follow the pathway of lumber from tree to building material.
(Students K-8)

Field Trip: Go to a lumberyard or home center. Using the writing process, write a story about the trip. You might want to mention the types of materials you saw, where they come from, how they are shipped, stored, sold and eventually used.

(Students 9-12)
Examine how demand in the housing market and supply of natural resources drive the prices of building materials up and down. Explore how external pressures like environmental regulations and interest rates influence the rate at which the building industry harvests and uses natural resources, and the prices of materials.

6 (Students K-8) Draw your house. Think of several kinds of houses and compare them. Identify ways that homes are alike and different.

7 (For students 9-12) Learn the anatomy of a building by systems. Compare a building's anatomy to human anatomy. Here are some examples of systems, to get you started: structural, electrical, mechanical, finishes. Discuss inputs to and outputs from the various systems of a building.

8 Learn to calculate linear footage and square footage area. What is the perimeter of your classroom? How would that knowledge help in obtaining materials for building a structure? What is the square footage of the room? Why would builders and designers need to know that information? What is the wall area? Why is that information important?

Introduction to Resource Efficiency

Now that you are thinking about where building materials come from, imagine what it would be like if we could learn to build houses that would be comfortable, practical and durable, but wouldn't use as many natural resources in their construction. This kind of construction would be **resource efficient**. It would consume less of limited resources than the kind of construction that is common today. Resource efficient construction uses more abundant materials rather than scarce resources, and it uses these resources in a way that produces less waste and pollution. Resource efficient building materials are recycled or recyclable, and they use less energy to produce and operate than ordinary building materials. Designs can be resource efficient, too. Resource efficient designs use fewer materials and less space to provide strong, functional structures.

Fortunately we don't have to just imagine resource efficient designs and materials. There are many ways to use them now, and they will probably be used more and more in the future. By learning more about resource efficient materials and designs now, you will be able to take actions throughout your life that will help protect and preserve natural resources for your children and their children, and many coming generations. The blocks in this unit will help you gain understanding of resource efficiency in construction–understanding that you can use in building our children's future.

Vocabulary of Resource Efficient Building

- **efficiency**
- **natural resource**
- **square footage**
- **life cycle**
- **linear foot**
- **dimensional lumber**

Block 1: Building Blocks

Instructor's Resource Notes

Examples of architectural design elements to look for in buildings

Balance
Repetition
Variation
Symmetry/Asymmetry
Curves
Angles
Lines
Shading/Shadows
Texture
Color

Additional information on design elements can be found in books on art or architecture. Students can look for examples of application of these design elements in the exterior of the school building and other buildings in the neighborhood. Another option is to identify design elements used in buildings by looking at pictures of several types of buildings: commercial, industrial, retail, residential in everything from single detached buildings to skyscrapers.

Consider how design elements contribute to the "feel" or message conveyed by a building. The formality or informality, color, angularity and textures of a building can provide clues to the function of the structure. Some buildings are meant to be inviting or convey a sense of fun. Other buildings are meant to be imposing and impressive. Students can learn to recognize examples of messages conveyed by the use of design elements in buildings they know, or in photos.

The application of design elements can also determine how a building fits into its surroundings. Some buildings are designed to blend in with the landscape. They may take their shape and color from local mountains, hills, or even vegetation. Buildings designed to blend in are often low to the ground or bermed into the ground. Other buildings are designed to stand out from the surrounding landscape and attract attention. Their shape, color and setting help them do this. Students can provide examples from their own experience or collect pictures of sample buildings. These exercises help students to identify the function of principles of visual arts in everyday life.

Common building materials and their origins

- Framing lumber–softwood trees such as fir, hemlock, larch, spruce, or pine, usually from the Pacific Northwest (41%) or the Southeast (32%) or imported from Canada (27%). Logs are debarked and sawn into dimensional lumber at sawmills, then planed smooth, and transported to job sites, where they are fastened using metal fasteners. Some wood is treated with preservatives made from arsenic, copper and chromium.
- Plywood and particleboard–veneers and wood fiber from hardwood, softwood and tropical wood, dried and then combined with adhesives such as phenol formaldehyde and urea formaldehyde or isocyanurate. Panels are then pressed and dried again, before being finished. (Plywood is used in roofs, sub-floors, walls, and furniture.)
- Wood trim or siding– redwood or cedar from the Pacific Coast, the Pacific Northwest and Canada, some softwoods such as pine, and some wood-based composites that include wood chips or sawdust and adhesives. Wood is dried, cut, glued, then finished.
- Interior wood flooring and trim– hardwood or softwood trees including maple, pine, oak. May be made from imported tropical hardwood species.
- Brick–shale and clay are ground, combined with water, formed into shape, and baked in a kiln at 2100° F. (Used in wall exteriors, paving, landscaping and chimneys.)

- Concrete–cement made from mined, crushed, heated and reground minerals (limestone, silica, alumina, iron, gypsum, clay), combined with water and aggregates such as gravel and sand. (Used in foundations and slabs, and in some walls.)
- Glass and fiberglass insulation–silica sand, calcium and magnesium from limestone, and many steps of heating. Fiberglass also contains dolomitic limestone and borax. Most of the sand used industrially in the United States comes from New Jersey, the Alleghenies and the Mississippi Valley and states from Pennsylvania to Illinois.
- Steel– iron ore (much from the area around Lake Superior; also found in Alabama, Utah, California, Texas, Pennsylvania and New York), lime (from limestone) and a large amount of refining energy, mostly from coal that is pre-processed into coke. About 66 percent of steel is recovered for recycling, so most new steel has at least some recycled content. A variety of finishes are added to steel for its different uses, and they include materials such as nickel, manganese, chromium, zinc, acids and alkalis. (Used in roofing or framing, or hardware, fixtures, windows or doors.)
- Aluminum–mined and ground bauxite ore (most used in the U.S. is imported from Jamaica, Australia, Guinea and Brazil), lime, caustic soda and high levels of refining energy produced by burning crude oil and coal. (Used in windows, hardware, roofing.)
- Plastic–petroleum-based. Some petroleum production takes place in the United States, but much of the oil used in the U.S. is imported from the Middle East. Different types of plastics follow different processes that may involve reacting, blending, drying, separating, reblending and pelletizing, followed by shaping into usable forms. (Plastics are used in fixtures, wiring, windows and doors, foam insulation, and as packaging.)
- Asphalt–petroleum refining byproduct that is heated and mixed with aggregates.
- Paint–produced from petroleum-derived chemical mixtures, paint may also contain water and some varieties contain metal.
- Vinyl flooring–PVC derived from (largely imported) petroleum, with chlorine, plasticizers, fillers and urethane added. (PVC is also used in plumbing pipe and for vinyl siding or windows.)
- Wallboard–gypsum, water and paper. Gypsum is a mineral that was deposited when ancient inland seas evaporated; major U.S. deposits are in Iowa, Oklahoma, Michigan, Texas, Nevada, California and Indiana. Recycled paper faces the wallboard and makes up its joint tape. Paper takes softwood pulp, water and energy. Joint compound is made from limestone or gypsum, clay, talc, mica, and perlite that are mined and mixed with water. (Used on interior walls and ceilings.)
- Carpet–mostly petroleum-based, derived from propane (polypropylene carpet) and benzene (nylon and polyester carpet). Carpet backing is polypropylene, or a natural fiber backing with foam coating. Carpet also includes dye made from inorganic or metalized organic chemical compounds. The production process uses a great deal of water, and installation uses adhesives.

For more information on the origins of building materials, consult the Environmental Resource Guide, an extensive (and expensive) subscription reference produced by the American Institute of Architects Committee on the Environment, or obtain an encyclopedia of industrial processes, or a reference like Energy Analysis of 108 Industrial Processes, from the U.S. Department of energy (a very technical document). Reference materials like these might be available at local libraries, college or university libraries, or the offices of local architects, environmental consultants, or industrial designers.

The class may be interested in discussing not only the origins of building materials, but also the environmental impacts associated with their extraction or harvesting, processing and use. Some examples of impacts that could be included in the discussion are: loss of wildlife habitat and aesthetic appeal due to mining or intensive logging; degradation of water quality due to siltation from logging, runoff or contamination from mining, or waste from industrial processing; air pollution from industrial processes and transport vehicles; production of solid or hazardous waste from industrial processes, and non-renewable energy use for manufacturing and transportation. County, state or federal regulators can often supply information on pollution, or private environmental professionals, or local environmental or citizens' groups may provide information on waste, air and water quality, and other environmental impacts.

Locally manufactured building products

Consult the yellow pages, or state manufacturing directories, to locate local manufacturers of building products. Ask local lumberyards if they carry any local products, or ask builders which products they use are made locally.

Examples of some local materials that could potentially be used to manufacture building materials:

- Trees / wood (many tree species, including hardwoods used in landscaping, plus wood from existing buildings, or even wood from shipping pallets)
- Stone (sandstone, limestone, granite, pumice, gravel, shale, slate)
- Minerals (talc, metal ores, gypsum, diatomaceous earth, silica, coal fly ash, etc.)
- Petroleum (for plastics and asphalt)
- Local fuels to power manufacture (petroleum, coal, hydropower, biomass, other renewable energy sources)
- Less obvious "raw material" sources that you will learn more about later in this unit: municipal and industrial waste (including tires, plastic and paper), agricultural fiber (such as straw), construction and demolition scrap.

Materials pathways–lifecycles

One way to establish the connection between natural resources and building materials is to backtrack the pathway of selected building materials. Stages in a typical pathway include harvest or mining, transportation, processing or manufacturing, distribution, installation and use and maintenance. More activities and information on pathways and lifecycles appears in Block 9, "Energy: Operating and Embodied." Older students can explore the impact that external forces such as environmental regulations, safety regulations, interest rates and market subsidies have on the materials pathway.

Comparison between a building's systems and human systems

- Structural system–like the skeletal system and muscular system combined, this holds the building up and provides a protective shell within which the other systems operate.
- Mechanical system–like the circulatory and respiratory systems, this transports fuel and heat and air through the building.
- Electrical system–like a cross between the nervous and endocrine systems, this supplies communication through a network of wires.
- Plumbing system–similar to the circulatory and excretory systems, the plumbing runs through the walls, ceilings and floors, supplying fresh water and carrying away used.
- Finish systems (siding, surfacing, paint, roofing)– like the skin, these help to provide a barrier between the world outside and the environment inside.

Word problems of square footage or linear footage

This type of skill is important for anyone building or buying a house, or anyone painting, wallpapering, buying carpet or other floor covering, seeding a lawn, adding insulation, choosing a furnace, putting in cabinets, installing a fence or hundreds of other building applications. The class can create and solve their own word problems relating to square footage or linear footage as applied to buildings.

Vocabulary of resource efficient building

- **efficiency**–lowest amount of input for maximum output, with minimal waste. Efficient building materials use fewer natural resources to perform a given task. Materials that are efficient generally create less pollution during their processing, installation, use and disposal. They are often durable in application and can be recycled or reused at the end of their useful life.
- **natural resource**–the raw materials that people use in their present form, or from which consumer products are manufactured. Some examples are trees, minerals, water, metal ores, soil, petroleum and air.
- **square footage**–the area of a room or building, usually measured by multiplying the interior dimensions together.
- **life cycle**–the history of a building product, including the action and energy involved in harvesting or mining the raw material, transporting it to a processing site, manufacturing a finished product, transporting it to the building site, installing the product, maintaining it during its lifetime, and removing and disposing of it or recycling it at the end of its useful life.
- **linear foot**–the measurement by which some building materials are classified and sold. Dimensional lumber is measured by the linear foot, instead of the square foot.
- **dimensional lumber**–wood that has been milled to specified sizes for use in building. Examples are beams, studs, planks and boards. The best-known piece of dimensional lumber is the 2" x 4".

Resources for research on related topics:

- World Watch Paper 124: A Building Revolution: How Ecology and Health Concerns Are Transforming Construction. Contact the World Watch Institute, 1776 Massachusetts Ave. NW, Washington D.C. 20036-1904. Tel 202-452-1999
Fax 202-296-7365 E-mail wwpub@igc.apc.org
- Building a Sustainable Society. Lester Brown. WW Norton: New York. 1980.
- The Closing Circle: Nature, Man and Technology. Barry Commoner. Knopf: New York. 1971.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities for this block.

Block 2: Sources and Resources
Overview

Goal:
To discover which recyclable materials are or can be sources of building materials.

Objectives:
1. Determine the materials in the classroom that can be recycled.
2. Introduce building products that are currently made from recycled materials.
3. Identify any materials that can be recycled into building products.
4. Explore new uses for these recycled materials.

Materials:
- maps of the city, state, region, USA; blank maps and maps showing resource distribution and maps showing population density.
- recycled paper, pencils, markers, scissors, glue, cardboard
- computer with Internet connection
- local telephone yellow pages
- calculators
- samples of building products that are currently made from recycled materials (can be obtained from CRBT)

Activity Summary:
- Identify common materials within your classroom and community that can be recycled to make building products. LA (S) (TS); S (E/M); SS (PE)
- Design and create new building products from recycled materials. Discuss the inventions and choose one to enter in the "Building Our Children's Future Material Design Contest" LA (L) (S); S (E/M); SS (TC) (PE); VA (AP) (MA) (V)
- Draw a map that shows locations of resources for building materials, including both primary resources and recycled or secondary resources. Compare resource supplies to population densities to learn more about markets for resources. S (O); SS (PE) (SR); VA (MA)
- Research different types of recycled building materials using books, periodicals and computers. LA (R) (TS); S (C); SS (PE)
- Practice math skills that relate to recycling and recycled building products. M (PS) (C) (CN)

Evaluation:
As a Class
- Add ideas to portfolios initiated in Block 1 Evaluation section.
- Class discussion.

Individuals
- Enter the CRBT design contest or have a classroom/schoolwide design contest.

Block 2: Sources and Resources
Activities

Although many building materials are manufactured from primary natural resources, more and more manufacturers are beginning to make products from recycled materials. People invent new recycled building products all the time, like shingles made from milk jugs or pieces of tires. Companies looking for new ways to use their waste sometimes invent new products from it. One company that makes plastic twist ties now uses their own industrial waste to make recycled plastic lumber. Products like these help to prevent waste, and help to conserve our natural resources. This block will help you to recognize recycling as an important step in making new building materials.

1 Working in small groups or as a whole class, try to identify which non-building materials right in your classroom or school are currently being recycled to make building materials. (Careful, the answers may surprise you!)

2 What other recyclable materials could be used? From your home? From your town? From your region?

3 What industrial waste or collected recyclable product would you like to find a use for? What building material would you make from it? Work individually or in groups to create concepts for new building materials. Present your concept to the class. The class can discuss each idea and choose one to submit to the "Building Our Children's Future" Material Design Contest.

4 Draw a map of Montana, the Pacific Northwest, the western United States or the U.S. Plot the location of natural resources: fossil fuels, minerals, agriculture, etc. Relate the location of these resources to population density. Understand the role of the West as supplier to the rest of the country. Where are resources that are mined and harvested here eventually used? What resources that we use here do we have to import?

5 Use the Internet or periodicals to learn about different types of recycled building products and their uses. (Your instructor has some hints about where to start.)

6 How many 2-liter pop bottles would need to be recycled to make enough carpet to cover your classroom floor?

7 How many newspapers would need to be recycled to add cellulose insulation of R-19 (R-value is a standard measure of resistance to heat flow) to the exterior walls of your classroom?

8 How many ground up tires would you need to surface your playground or athletic field with crumb rubber?

Block 2: Sources and Resources

Instructor's Resource Notes

Examples of common classroom materials that are being recycled to make building materials

- Aluminum cans–recycled into window frames and roofing
- Steel (desks, hardware)–recycled into steel studs, trusses, roofing and siding
- Styrofoam–recycled into rigid foam board insulation
- Plastic bottles–recycled into carpet or plastic lumber
- Glass, including used light bulbs–recycled into aggregate for concrete or into ceramic tiles
- Paper (especially newsprint)–recycled into cellulose insulation, facing for gypsum wallboard, tile or core for honeycomb panels
- Clothing–recycled into carpet pad or insulation

Examples of other common materials that can be recycled to make building materials

- Tires–tile, matting, carpet pad, roofing, or filled with rammed earth and used as walls
- Other forms of steel–(cans, cars, buildings, railroad rail, machinery and equipment)
- Wood waste–wood composite products (including siding, fiberboard, fiber cement siding and roofing), engineered wood products
- Concrete–broken into aggregate

Sources of information on recycled building products

Many of these information sources have a subscription or purchase cost, but may be available for use at local libraries, or may be accessible through local designers or builders. Free products are noted as such.

Periodicals

- Resource Recycling–a monthly magazine with news on resource recovery equipment and management, and frequent news on recycled building materials. Resource Recycling, P.O. Box 5234, Pittsfield, MA 01203-9664.
- Environmental Building News–a bimonthly technical newsletter with in-depth features on construction materials and topics. RR 1, Box 161, Brattleboro, VT 05301. E-mail ebn@sover.net

Directories

- Recycled Plastic Products Sourcebook–free from the American Plastics Council by calling 800-2-HELP-90.
- Guide to Resource Efficient Building Elements–an annually-published directory of manufacturers of recycled and resource efficient building products, with introductions. Center for Resourceful Building Technology, P.O. Box 100, Missoula, MT 59806. $25.
- Directory of Recycled-Content Building and Construction Products–Clean Washington Center, Department of Trade & Economic Development, 2001 Sixth Avenue, Suite 2700, Seattle, WA 98121, phone (206) 464-7040. Minimal cost.
- Guide to Recycled Products, Construction and Industrial–Metro, 600 NE Grand Ave., Portland, OR 97232-2736, phone (503) 797-1700. Minimal cost.
- REDI Guide (disk)–Iris Communications, 258 East 10th Ave, Suite E, Eugene, OR 97401, phone 503-484-9353. $49.

- Harris Directory (disk)–Stafford Harris Architects, Seattle, WA, phone (206) 682-4042. $69 with one six-month update.

Internet
- Plan It Earth! Marketplace
http://www.numenet.com/planit/pe_market.html
- Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook/

Word problems on recycled products

For the recycled plastic carpet word problem, first find the square footage of the classroom. Next, convert this to square yards, the standard measurement for carpet, by multiplying by .11. Finally, multiply by 40, the number of plastic 2-liter bottles in each square yard of carpet. The recycled rubber question is similar. There are 160 tires per ton, and a ton of crumb rubber surfacing material covers 150 square feet.

For the cellulose insulation, weigh your local newspaper to determine how many newspapers it takes to make 20 pounds. 20 pounds of newspaper makes enough insulation to cover 40 square feet to a depth of 6" (which produces R-19). Find the area of the exterior walls in square feet. How many 40-square foot-coverage bags of insulation would it take for this area? Now multiply that number by the number of newspapers in 20 pounds, to determine the total number of newspapers needed for insulating the exterior wall to R-19.

Resources for research on related topics:
- The Next Efficiency Revolution: Creating a Sustainable Materials Economy. WorldWatch Institute, 1776 Massachusetts Ave. NW, Washington D.C. 20036-1904. Tel 202-452-1999 Fax 202-296-7365 E-mail wwpub@igc.apc.org
- World Resources 1992-1993. World Resources Institute. Oxford University Press, New York, 1992.
- Biologic: Designing with Nature to Protect the Environment. David Wann. Johnson Books: Boulder. 1994.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities for this block.

Block 3: Sources and Resources: Housing Around the World

Overview

Goals:

1. To make students aware that housing differs depending upon available materials.
2. To explore the effects of cultural influences on housing style.

Objectives:

1. Identify different housing styles in the world.
2. Pinpoint the natural resources available in different regions.
3. Match the housing styles with the resources available.
4. Investigate the various familial, religious, economic and social influences which affect regional housing design.

Materials:

- world map or overhead projector and map transparencies for tracing maps onto poster paper
- poster paper, markers, magazines, rulers, glue, pins, etc. for creating a wall map
- references on worldwide housing and cultures; National Geographic and other magazines for collage and elaboration
- world atlases showing resource distribution

Activity Summary:

- Find examples of the types of housing used elsewhere in the world, through the study of other regions. Focus individual study on a number of different regions, to identify housing types in those areas. LA (R); SS (CR) (GP) (SR); VA (VH)
- Examine natural resource distribution in the world using maps, and consider how available resources determine housing materials and styles. S (I) (O) (V); SS (GP) (SR)
- Find examples of ways that culture and society influence housing design and construction around the world. LA (TS); SS (CR) (GP) (TC) (SR) (SC); VA (AP) (VH)
- Invite speakers from other areas to talk about natural resources, culture and housing. LA (L); S (V); SS (CR) (GP) (SR) (SC)
- Locate the results graphically on a world map. (Save the map to use and elaborate upon in block 8.) S (O); SS (GP) (SR); VA (MA)

Evaluation:

As a Class

- Wall map can be evaluated with agreed upon criteria generated by the group.
- Wall map can be evaluated with agreed upon criteria generated by the instructor.
- Wall map can be evaluated with criteria generated by the group, with basic requirements from the instructor.
- Different aspects of the map can be emphasized, depending upon the subject area, and therefore, different criteria can take precedence.
- Add notes on cultural influences on housing to portfolios generated in Block 1.

Individuals

- Write a report on the resource distribution and housing styles of a particular region or country.
- Complete journal entries and notes from speakers.

Block 3: Sources and Resources: Housing around the World
Activities

Have you ever been traveling somewhere and noticed that the houses looked different from the ones in your town? Maybe you watched a movie or read a book that showed houses very different from the ones you are used to. This block helps you to explore some of the reasons that houses in different parts of the world don't look the same.

1 What materials do people in other countries build from? Why do they choose these materials? Where do the materials come from? How far do they travel to the building site? How are these materials applied?
What types of fuel are used? Is fuel available locally or imported?

2 Who does the building? Do building professionals construct homes, or does each family construct its own housing?

3 Invite someone who has lived in another country to talk to your class about how housing there differs from housing here.

4 **A.** Use a map or atlas to identify a country or region of interest to you. Discover the types of resources that are available in the region you have chosen. Find out what traditional or typical houses in that region are made from and what they look like.

B. Learn about cultural influences on housing.
Who lives together? (Grandparents, grown children, siblings, cousins) How big are families, and how many children are typical?
What do people do for entertainment?
How many years do they go to school and where?
How long do people live in one place? How long do houses last?
How important is owning a house? Can people rent houses, or do they live with their families until they can buy a house? Do several generations live on the same land?

5 With your classmates, put the results of all of your regional studies on a map of the world. Label regions and resources. Draw examples of typical housing.

Block 3: Sources and Resources: Housing around the World
Instructor's Resource Notes

Some examples of the types of local resources used to build housing in locations around the world

- snow and ice blocks–igloos are built for winter housing in extreme northern climates.
- adobe and/or rammed earth–soil containing both sand and clay is either cast into blocks or tamped onto walls. These building systems work best in arid climates.
- palm leaves–palm and other plant leaves and fibers make a biodegradable, readily-available roofing material in tropical climates.
- reeds–some types of reeds are used for roof thatch in northern climates.
- animal hair–yurts are a type of round tents made from felted animal hair and used by herders in Asia.
- animal hides–herders and hunting cultures worldwide have used animal hides in constructing temporary and mobile shelters.
- grass–people on grasslands weave, bundle, or pile plentiful grasses to make huts that provide shelter from the sun.
- logs or timbers–in forested areas of both the Northern and Southern Hemispheres many people build with logs or timbers harvested near the building site. People in these forested areas may use whole logs, saw boards or beams from the logs, or split shakes for use as roofing or siding material.
- cob or straw/clay–in agricultural areas with few trees, people in Europe historically combined straw and clay to form walls.
- strawbales and sod–in agricultural areas with few trees in the United States, people built from blocks of sod or bales of straw.
- stone–stone walls and houses are common in mountainous areas where there are few other building materials, and in agricultural areas where stones are turned up in cultivated fields and then removed for building.

Selected examples of housing design and construction influenced by culture and societal influences

- door facing east–some Native American religious beliefs state that the door of a dwelling should face east so that occupants can greet the rising sun.
- round buildings–some cultures and religions believe that round buildings are an important metaphor for the circle of life and a sign of wholeness.
- space for grandparents/extended family–in some cultures several generations or extended family units live together in the same house or compound. They may all share communal cooking, dining and living spaces, or each immediate family group may have its own private space within the compound area. In the United States today, many new houses have a special space with its own entry or cooking facilities, to house the parents or grandparents of the family.
- communal cooking or meeting area– in some cultures all dwellings are clustered around (and oriented to face) a communal central area that is used for group activities that may include cooking, eating, group working, or meeting. In the United States this pattern is seen in old settlements in New England that feature a town square.
- fortress/cabal–some cultures group houses close together and surround them with a wall or fence for security. This is true of many old European villages, and is becoming more common now in the United States, where many new communities offer walls and

gates to promote a feeling of security for residents. Individual properties can also be surrounded with walls or fences, like European castles and modern estates.

- enclosed passageways between buildings–in some northern climates, including New England, people build enclosed passageways between houses and barns, so that they don't have to go outside in winter to care for animals.
- multi-car garage–in the United States many new developments are very automobile dependent. People must drive to get to the places where they work, shop, learn and play. New neighborhoods often have wide streets with no sidewalks, and few people walk. Because of this, new houses feature large garages, often at the front of the house. Garages often comprise 40% of a house's front **elevation**, or view from the street. In some areas planners and architects are working to design communities for people instead of cars. These areas have narrow streets, sidewalks and front porches, and garages are usually at the back of the lot.

Resources for research on related topics:

- Spectacular Vernacular: The Adobe Tradition. Jean-Louis Bourgeois, Aperture, NY. 1989.
- Great Structures of the World. H. Arthur Klein, World Publishing Co. 1968.
- The Encyclopedia of the Peoples of the World. Amiram Gonen, ed. 1993.
- Atlases that show resource distribution.
- Encyclopedia topics on buildings or architecture.
- National Geographic.
- Exchange students' and immigrants' experiences in other countries.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities for this block.

Block 4: Sources and Resources: Reused or Recycled?

Overview

Goals:

1. To differentiate between recycling and reusing materials.
2. To compare the energy required for reuse with the energy used for recycling.
3. To inspire students to think of used materials as useful materials.

Objectives:

1. Introduce the processes of refurbishing and remanufacturing materials.
2. Establish an awareness of the potential for reusing materials.

Materials:

- examples and photos of recycled and reused materials
- large poster paper, markers, or computer graph programs

Activity Summary:

- Differentiate recycling from reuse. LA (TS)
- Generate lists of ways to divert materials from landfills, and decide through discussion whether each action is recycling or reuse. LA (S) (TS); S (E/M); SS (PE)
- Identify uses and applications for recycled and reused products. LA (TS); S (E/M); SS (TC)
- Research and illustrate the energy savings possible from reuse of materials. Compare with the energy savings provided by recycling. M (PS) (R) (CN); S (I) (E/M); SS (PE)
- Draw a web diagram of interactive relationships between materials, humans and the environment. LA (TS); M (C); S (E) (I) (O); VA (MA)

Evaluation:

As a Class

- Discussion of ratios and percentages.
- Presentations of the data collected in graph form.
- Portfolio additions of graphs, illustrations, and lists.
- Videotape presentations or debates on issues surrounding recycling and reuse.

Block 4: Sources and Resources: Reused or Recycled?

Activities

From Block 2 you already know something about the recycling of materials to make new building materials. Recycling isn't the only way to keep waste out of landfills and reduce the demand on natural resources, though. Some materials can be reused in their present form, even without being recycled. We call it reuse when a product keeps its current form in its second use. A product can be cleaned, repaired, painted or sanded before reuse, but it stays in essentially the same form.

When a product is recycled, on the other hand, its form changes. The material is ground or shredded or melted or broken up, and remanufactured into a new product in a new shape. This block offers an opportunity for further study of recycling and reuse.

1 Working as a group, make lists of ways to divert materials from landfills, then:

A. Decide whether each activity is recycling or reuse, or neither.

B. Decide which activities require more energy and/or resources.

C. Decide how the recycled products could be used or where the reused products could be applied.

2 How much energy is saved by reusing a bottle or can instead of recycling it? How much by recycling instead of using new resources? How much by reusing instead of new resources?

A. Present your answers in ratio form or as percentages.

B. Present the data you collected in graph form.

3 Sometimes waste building materials are burned in an incinerator to generate energy. Some of this energy is used to manufacture new building materials. Is this really recycling, or is it consumption? Choose roles to play in debating this issue, such as: the product manufacturer, the energy generator, the construction industry, community members, and people living next to the incinerator.

4 Draw a web diagram that illustrates the interactive relationships between materials, humans and the environment around us. How do some waste materials become resources for other groups of resource users or other species?

Block 4: Sources and Resources: Reused or Recycled?
Instructor's Resource Notes

Examples of actions that divert materials from landfills, and listing as reuse or recycling

- collecting aluminum cans–recycling
- collecting glass bottles–reuse or recycling
- collecting newsprint–recycling
- saving paper with a blank back–reuse
- saving vegetable and fruit and other food waste for composting–recycling
- donating old clothes or toys to charities–reuse
- donating old carpet to animal shelters–reuse
- taking old carpet to collection centers–recycling
- taking old paint to a materials swap–reuse
- using old bricks to make a patio or sidewalk–reuse
- using wood scraps to make a birdfeeder–reuse
- using old doors as desks–reuse
- using old windows in a greenhouse–reuse
- waste to energy conversion–recycling, or not?

Energy savings of recycling versus using new resources for selected materials
If reuse of a material is possible, it almost always requires even less energy than recycling the material.

	Energy required to produce from virgin material (million Btu/ton)	Energy saved by using recycled materials (percentage)
Aluminum	250.0	95
Plastics	98.0	88
Newsprint	29.8	34
Corrugated cardboard	26.5	24
Glass	15.6	5

Source: Resource Recycling Jan/Feb 1989

Resources for research on related topics:

- EPA "Reusable News," U.S. Environmental Protection Agency, 401 M Street SW, Washington, DC 20460. A free newsletter on recycling and waste prevention.
- Resource Recycling–a monthly magazine with news on resource recovery equipment and management, and frequent news on recycled building materials. Resource Recycling, P.O. Box 5234, Pittsfield, MA 01203-9664
- Building for Tomorrow: Putting Wastes to Work. Martin Pawley. Sierra Club Books: San Francisco. 1982.
- Mining Urban Wastes: The Potential for Recycling. Cynthia Pollack. WorldWatch Paper No. 76, April 1987.
- 50 Simple Things Kids Can Do to Recycle. Earth Works Group. Earth Works Press. 1994.
- Local materials recovery and recycling facilities or salvage and reuse centers.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities for this block.

Block 5: Sources and Resources: Use and reuse and reuse and...
Overview

Goals:
1. To introduce the idea that demolition can be a creative process.
2. To inspire students to think of used materials as useful materials.
3. To recognize the potential of old buildings for new uses.

Objectives:
1. Trace the history of objects passed down through generations.
2. Relate this legacy to passing buildings or building materials from person to person.
3. Introduce ways the uses of buildings change over time.

Materials:
- pictures of different types of buildings for identifying reusable components
- examples of objects from families that have been handed down through generations
- history of one building's past from your town, and/or plans for future use for the structure (or neighborhood structures) from your town's records
- computer for writing histories and gathering data

Activity Summary:
- Relate the handing-down of objects to the process of reusing building materials. LA (R); SS (TC) (SH)
- Use pictures of buildings to facilitate a discussion that includes the identification of materials that could be recycled and/or reused. LA (L) (S) (TS); S (C) (T/S) (E/M); SS (TC); VA (AP) (V)
- Have each class member document the history of a building, and share these histories with the class. LA (W) (S); SS (TC) (SH)
- Trace the historical reuses of buildings in your town and project future uses for these structures. Compile a scrapbook of your findings. LA (W) (R) (TS); S (C) (T/S); SS (CR) (TC) (SH); VA (AP) (MA) (VH)

Evaluation:
As a Class
- Working as a class, put together a scrapbook with pictures and written histories of your town and its buildings.

Individuals
- Each class member documents the history of a building, and presents it to the class.
- Add copies of history reports to student journals.
- Each class member draws a plan showing a future use for an existing building in the town, including alterations to its function, decoration and landscape.

Block 5: Sources and Resources: Use and reuse and reuse and ...

Activities

Many things are passed down from person to person for generations. Maybe your family has a table, a lamp, a dish or a picture that belonged to your ancestors, and that your family has kept for many years, perhaps through several moves. Some building materials can also be saved for use in new houses, where they can serve for generations. Sometimes houses themselves are passed down from generation to generation.

The same kind of thing can happen with other buildings in a town. A commercial building constructed for one purpose often gets used for many other purposes during its lifetime. Many older downtown areas have office buildings that were once hotels or houses, retail stores that were once banks or offices, and restaurants that were stores, offices, or even railroad cars. Reusing buildings is a great way to prevent wasted building materials and to avoid the need for new building materials. If a whole building can't be reused, it is often possible to reuse many parts of it in new structures. This block provides the opportunity to explore reuse of whole buildings and individual building materials in your family, home, and community.

1 Look at some pictures of buildings and have a discussion about the future of the materials in them. If these buildings were demolished, what would happen to their materials?
What materials from these buildings could be recycled? What materials from these buildings could be reused? Review the difference between reusing and recycling materials. What materials can be reused in their present form? What materials can be reused with only minimal reprocessing?

2 Does your house contain any materials that were reused? Maybe your whole house is reused. How long has it existed, and how many families or generations of the same family have lived there since it was built? Determine the history of your own house, your grandparents' house, or another building you are familiar with. Write the story of the building you researched and share it with your class.

3 If you were remodeling or even demolishing your house to make way for new construction, which materials would you most want to save? What other materials could be saved for reuse?

4 Are there buildings in your community that have been adapted and reused for different purposes since they were constructed? Look at historical photos of your community. Which buildings are still there? How have they changed over time? What do you think they and other buildings that exist now will be used for in the future?
Take field trips to your local library to check historical archives and trace the history of buildings in town, and to older areas of downtown to locate reused buildings and learn more about them. Working as a class, put together a scrapbook with pictures and written histories of your town and its buildings.

Block 5: Sources and Resources: Use and reuse and reuse and...

Instructor's Resource Notes

Examples of building materials that can be reused...

...in their present form

doors
sinks and bathtubs
insulation
door knobs
door frames and trim
metal staircases
wood stair railings and newel posts
steel studs
fireplace mantels
windows and stained glass
cabinets
many light fixtures
wood beams (if structurally re-rated)
ornamental moldings
bricks as patios or in landscaping
wrought iron work
steel roofing
tiles

...with minimal reprocessing

broken sidewalk stacked in retaining walls
doors made into cabinets, railings, or trim
old wood studs and sheathing remilled as trim
wood doors milled into cabinet faces and trim
old wood beams milled into flooring
wood flooring refinished and re-laid

Examples of building materials that can be recycled

aluminum awnings and trim
paint (or some leftover paint can be reused)
wood pallets
wood scrap ground for use in hardboard
some asphalt shingles
steel studs and roofing
cardboard packaging
gypsum board
concrete into aggregate

Notes on reuse of historical buildings within a town

Many towns have a historical downtown section that dates from the founding of the town. Stone or brick buildings that were once banks, hotels, or theaters can still be visible today as offices, apartments or retail stores. Even in younger towns and recently developed areas, buildings often undergo remodeling and reuse. Students may recognize the process of adaptive reuse occurring within their own lifetimes in buildings that have housed a succession of restaurants, retail stores or offices. Some buildings are adapted for reuse every few years. Other reuse is on a much longer time line. Look for examples of both types of building reuse in your own town.

Resources for research on related topics:

- "Traditional Building" (magazine) 69A Seventh Ave., Brooklyn, NY 11217
- "This Old House" (magazine) Time Publishing Ventures, write This Old House, P.O. Box 58368, Boulder, CO 80322-8368 Tel: 800-898-7237.
- How Buildings Learn. Stewart Brand of the Global Business Network, 5900X Hollis St., Emeryville, CA 94608 Tel: 510-547-6822.
- Building with Salvaged Lumber. Elizabeth Williams. TAB Books. 1983.
- Salvaging Old Barns and Houses: Tear it Down and Save the Pieces. Lawrence Abrams. Sterling Publishing Co. 1983.
- See pages L1-L12 "Learner Outcomes" for ideas on additional methods and activities for this block.

Block 6: Before Buildings
Overview

Goals:
1. To recognize the effects construction has on a site.
2. To learn environmental considerations involved in planning land use.

Objectives:
1. Research the history of the town site and school site.
2. Show how the presence of the town and school have changed the original landscape.
3. Create a site plan for a new building that exhibits consideration for the environment.
4. Recognize opportunities for habitat restoration.

Materials:
- map of school site and historical resources for the school, such as archives and blueprints
- historical resources for the town, including maps, historical photos, newspapers, town records, land sale deeds and other documentation
- CAD program, drafting tools and table, or graphing paper and hard pencils
- field guides to animals, plants, insects, birds, amphibians, etc.
- resources, slides, or visiting lecturers which illustrate components of habitat and how construction alters habitat
- computer for writing habitat protection plan drafts

Activity Summary:
- Research and record what existed on the site of buildings and towns before these areas were developed, how developed areas have been impacted by development as town grew, and how sites where building resources were extracted have been impacted. LA (R) (TS); M (G); S (C) (I) (T/S); SS (CR) (TC) (SR)
- Write a reaction to the impact of development on a particular site. LA (W); S(C); SS (CR) (TC)
- Invite a guest speaker to help you become familiar with the concept and components of habitat, and examine how construction alters habitat. LA (L); S (C) (E) (I)
- Identify strategies for habitat restoration at your school. Create and look for ways to implement a plan for habitat restoration. LA (W)(S) (TS); M (G); S (C) (E) (I) (T/S); SS (SC); VA (C) (MA)
- Explore options for site and habitat protection when siting and constructing new buildings. Create a sample site plan for a new building, emphasizing habitat protection. LA (W); M (G); S (C) (E) (O); SS (SR) (SC); VA (C) (MA)

Evaluation:

As a Class

- Draw a site plan or construct a model of a new building including such features as building footprint, topography, vegetation, roads, sidewalks, playgrounds and parking lots.
- Create a plan for habitat restoration at your school and present it to the administration.
- Add notes on research on the history of the town and its environment to class portfolios.

Individuals

- Write a reaction to the impact of development on a particular site in your journal and to the local newspaper.
- Begin a journal of changes in habitat and the structures on the land to hand down to the next generation or next owners of the property.
- Give an oral book report on a book or regional biology or habitat, read independently of the class.

Block 6: Before Buildings
Activities

Imagine what the site of your town might have looked like when the first people to see it arrived. It has probably changed a great deal since then. Those changes didn't occur all at once, but gradually, as the town grew and new buildings were constructed. Historical records and older residents can help you to trace the process of change in recent history.

Each new building that is constructed changes the environment immediately surrounding it. Often the habitat that the wild plants and animals had on the site is destroyed or altered when a new building is built and landscaped. However, with careful planning a building can be designed to disrupt the environment as little as possible, and a site can still provide habitat for native plants and animals. This block encourages you to identify how buildings have changed your local environment and helps you discover ways in which buildings and the natural environment coexist. You can also investigate and implement strategies for restoration of ecosystems and habitats that were previously altered by construction.

1 Is your school a new building or an old building? Look on the front of the building for the construction date, or ask someone who has worked there for a long time (maybe the principal, a teacher, janitor or librarian).

2 Where did the natural resources it took to build your school come from? What do you think that place looked like before the resources were extracted? What does it look like now?

3 What was on the site of your school before a school was built there? Was the building used for something else before it became a school? Some suggestions for finding out:

- Ask someone who has lived in the town for a long time.
- Find old newspaper articles from the time the school was built and opened.

4 What was on the site of your town before the town existed?

- Look for written histories of the area.
- Look at a map and see what kind of land surrounds the town.

5 **A.** Trace the history of your town as it has grown over time and the impact this has had on its environment. Invite a speaker to your classroom who can talk about what the town and surrounding area were like long ago. Geologists, archaeologists, anthropologists, historians, and senior citizens are potential speakers. Take a field trip to the local library to explore local histories and newspaper archives.

B. Identify and react to developmental change in your town. Can you remember a site in your town/neighborhood that didn't have buildings before, but does now? Write about the place before and after the change, and how you felt when it changed.

6 Does anything that existed before your school was built still exist on the school site? (Trees, streams, open fields, sheds or outbuildings, animals, plants) If these things are missing, why are they not found there?

7 Learn about habitat: what is it and what do you need to have a habitat? What makes up a habitat – for animals? – for plants? – for people? Don't forget birds, amphibians, reptiles and insects. Invite a biologist to assist in identifying components of the habitat near the school. What pieces of habitats for different living organisms are missing from your school site? How can they be restored? Figure out which plants and animals use the habitat now, and which ones could use it if it were altered to be more like a natural habitat. Create a plan for habitat restoration of the area, showing which areas should be changed, how they should be changed, and what the results would be.

8 Create a site plan for a new building. Where would you put it and how would you moderate its impact on habitat? If you were planning to design a new school, where would you put it and why? How would you protect what is on the site? How could you restore some of the natural environment that was disturbed by building? Draw a site plan including such features as building footprint, topography, vegetation, roads, sidewalks, playgrounds and parking lots.

Block 6: Before Buildings
Instructor's Resource Notes

Identifying habitats and native plants and animals

When identifying native residents of a site, and components of habitat, remember to discuss the habitat needed not only for people and other animals, but also the types of habitat needed for a complete ecosystem, including the plants, birds, insects, fungi, reptiles, amphibians, and possibly even fish. The concept of habitat includes food and water supplies, shelter or cover, and space.

Related concepts for additional research include: minimum viable population, migration corridors and habitat islanding. If suitable habitat areas are small, and separated by great distances, isolated populations may not survive in the long term, due to lack of genetic diversity and vulnerability to local natural disasters or disease epidemics.

Many people are qualified and willing to help in identifying native species and the type of habitat they need. These individuals can assist in determining strategies for habitat restoration. Some potential collaborators on this project include: wildlife and fisheries biologists from colleges or the state fish and wildlife service; range management specialists from a university extension service or the Soil Conservation Service; foresters from the USDA Forest Service, state forestry office or lumber companies; birdwatchers from the local Audubon Society.

Notes on habitat restoration

Once again, habitat includes sources of water, food and shelter. Attempts to restore native species to an area should consider ways of providing these needs. Often, planting native vegetation is a good way to attract wildlife to a site and promote biodiversity. Plants should be chosen for their ability to furnish food and cover for native animals. Typical lawns have little biodiversity, and offer little habitat. They can be expensive and difficult to maintain.

By contrast, restoring native vegetation at a site has many benefits for property owners. It can result in greatly reduced maintenance costs, since native vegetation usually doesn't require supplementary irrigation, fertilization, mowing or pruning. In addition, native vegetation has root systems evolved for that soil. Thus, the roots can stabilize the soil, preventing erosion and capturing stormwater to prevent runoff. These benefits make native vegetation a wise choice for the property owner, as well as the environment.

Sources of additional information on native landscaping

- The Wild Lawn Handbook: Alternatives to the Traditional Front Lawn. Stevie Daniels, 1995. Macmillan, 15 Columbus Circle, New York, NY 10023. $20.
- Going Native: Biodiversity in Our Own Backyards. Janet Marinelli, editor, 1994. Brooklyn Botanic Garden, Inc. 1000 Washington Avenue, Brooklyn, NY 11225. $6.95.
- The Resource Guide to Sustainable Landscapes and Gardens. Wesley A. Groesbeck and Jan Striefel. Environmental Resources, Inc. 2041 East Hollywood Ave., Salt Lake City, UT 84108. $37.50.
- Energy-Efficient and Environmental Landscaping. Amy Simon Moffat and Marc Schiler. Appropriate Solutions Press, Dover Road, Box 398, South Newfane, VT 05351.

Strategies for site protection during construction

- Plan the routes that heavy machinery will use before construction begins, and restrict machinery to these routes.
- Place the building on the site in a location that allows existing trees to be preserved.
- Protect trees by fencing an area around the drip line, or their shadow when the sun is directly overhead. This keeps their roots from being severed or their soil from becoming too compacted during construction.
- Before site work begins, dig up plants from the footprint of the building and the access area. Save these plants in pots for use in landscaping the site when construction is complete.
- Avoid the dumping of chemicals, paints and other toxic materials on the soil or where they can run into nearby bodies of water.
- Avoid construction activity or access through especially sensitive areas such as wetlands.

Sources of additional information on site protection

Global ReLeaf for New Communities, American Forestry Association, P.O. Box 2000, Washington, DC 20013.

Resources for research on related topics:

- Local histories of the town. Longtime residents. Historians. Old maps of the area. Early city directories. Libraries with information on local history. Newspaper archives.
- Design with Nature. Ian McHarg. Doubleday/Natural History Press: Garden City, NY. 1971.
- Nature's Design: A Practical Guide to Natural Landscaping. Carol A. Smyser. Rondale Press. 1982.
- See pages L1-L12 "Learner Outcomes" for additional ideas about methods and activities for this block.

Block 7: Forces of Nature: Local Design
Overview

Goals:

1. To learn about the local climate.
2. To learn how climate dictates building design and how people build in response to their climate.
3. To evaluate the appropriateness of local building with respect to the climate.

Objectives:

1. Determine the climatic variables of our region.
2. Analyze the appropriateness of the buildings in our area with respect to climate.
3. Introduce building styles based on these variables.
4. Explore the effect of microclimates on buildings.

Materials:

- weather data for the local area, and information on local climate
- writing lab or student disks for writing reports
- old cardboard, toilet paper and paper towel tubes, wire, plastic, foam rubber, polystyrene foam from packing boxes, etc., to build models

Activity Summary:

- Research the local climate and other forces of nature that affect local building design. LA (R); M (C); S (C) (O) (V); SS (SR)
- Correlate climatic effects with building energy usage. M (CN); S (I) (E/M)
- Evaluate the appropriateness of local buildings for the climate, considering both materials and design. LA (TS); S (C) (I) (V); SS (SR); VA (V)
- Explore ways to create a microclimate that moderates the way forces of nature affect a building. LA (TS); M (G); S (C) (E) (I); SS (SR)
- Create a microclimate plan for a specific site, and implement it. LA (S) (TS); M (G); S (C) (E) (I) (O) (V); SS (SR) (SC); VA (C) (MA)

Evaluation:

As a Class

- Draw and write a microclimate modification plan for your school, and present it to the administration, along with data to support how the plan will save energy and increase comfort levels for building users.

Individuals

- Write or give an oral report which correlates climatic effects with building energy usage, evaluates the appropriateness of local buildings for the climate considering both materials and design, or shows the local climate and other forces of nature that affect local building design.
- Keep taped or written reports in student portfolios.
- Create environmental art which might help wildlife surrounding your community cope with encroaching human population, climatic conditions and pollution.

Block 7: Forces of Nature: Local Design
Activities

Just as we choose our clothes based on the weather outside, it is important to "dress" our houses for the climate where they are located. Preparing a house for the weather and other forces of nature will help it last longer and reduce the amount of energy needed to heat and cool it. Becoming familiar with the climate of your area will help you learn to evaluate the suitability of local buildings for their location.

Even though we can't do much to change the climate that surrounds a building, there are ways to change the **microclimate** of a structure. Changing the microclimate by planting trees, building fences or creating berms can also help reduce the amount of energy used in heating or cooling. This unit suggests some ways to suit a building to the climate and ways to site a building for taking advantage of the microclimate.

1 What forces of nature affect the area where you live?

Has there ever been an earthquake?
Are there wildfires?
Are there ever tornadoes? Hurricanes?
How much snow falls?
Do you live near a waterway? How often does it flood?

2 What is the climate like? Consult the national weather service, a meteorologist, or an almanac for more information on the local climate.

How much rain and snow fall each year?
What is the average wind speed?
How many days of sunshine each year?
Average temperature in winter and in summer?
Degree days of heating and cooling?
Extreme temperatures? What is the coldest day you remember?
How did you deal with the cold?
Hottest day? How did you escape the heat?

3 Predict how energy usage will correspond with changing seasons. Consult your local utility company. Does the actual data support your predictions?

4 Why is it important for buildings to meet local climate conditions?
What features would you put in a building to make it meet your local conditions?
Evaluate several buildings in your town and decide whether they are designed for your climate. Record answers to questions you have concerning different building practices. Compare findings from each site in order to help you make choices about the style of building you would create.

5 Vegetation and natural features can help mitigate the effects the climate has on buildings. For example, trees can provide shelter from cold wind or shade from the sun. Earth berms can insulate houses, and hills can shade them. Hedges or exterior walls can channel cooling breezes. Research or invent some other options for creating a microclimate for a building.

6 Create a sample building site (or several, if you want to work in small groups.) Where would you put a building on this site, and why at that place? How would you design the building to adapt it to the climate? The site and its surroundings? What local materials could you use? (See Block 2 for ideas.)

7 Consider the location of your house or school.
What natural landforms affect the climate? The microclimate? What vegetation affects the microclimate? Where and what kind of vegetation could be added to make the microclimate more hospitable?
Draw and write a microclimate modification plan for your school, and present it to the administration, along with data to support how the plan will save energy and increase comfort levels for building users.

Block 7: Forces of Nature: Local Design

Instructor's Resource Notes

Adaptations in buildings that reflect the effects of the local climate
(which ones are relevant depends on your local climatic conditions)

- houses on stilts in flood areas
- "arctic entries" on northern cold climate houses
- covered passages from house to garage or barn in cold or rainy climates
- cooling towers or evaporative pools for houses in hot climates
- adobe finishes in arid areas, and water-resistant finishes in wet climates
- thick walls for thermal mass in climates that are hot during the day and cold at night
- no basements where groundwater is high
- thick insulation in walls, roofs and floors where temperature is extreme

Examples of strategies for creating microclimates for buildings

- shelterbelts of coniferous trees
- summer shade (and winter sun) from deciduous trees
- hedges or landscaping walls to channel breezes
- earth berming to moderate temperature swings
- window placement to allow ventilation
- ponds for evaporative cooling
- catchment channels and ponds for stormwater runoff

Examples of benefits from creation of microclimates

- reduced heating load
- reduced cooling load
- improved ventilation
- increased comfort level
- more frequent use of landscaped areas
- reduced problems dealing with stormwater, and reduced need for irrigation
- improved productivity and lowered stress from greenspace access

Sources of additional information on creating microclimates

- Cooling our Communities–A Guidebook on Tree Planting and Light-Colored Surfacing. U.S. Environmental Protection Agency, 1992. Washington, D.C.
- Energy Saving Landscapes: The Minnesota Homeowner's Guide. Minnesota Department of Public Service, State of Minnesota, 1993.
- Landscaping for Energy Efficient Homes. U.S. Department of Energy Fact Sheet 220, April 1988.
- The Resource Guide to Sustainable Landscapes and Gardens. Wesley A. Groesbeck and Jan Striefel. Environmental Resources, Inc. 2041 East Hollywood Ave., Salt Lake City, UT 84108.
- Energy-Efficient and Environmental Landscaping. Amy Simon Moffat and Marc Schiler. Appropriate Solutions Press, Dover Road, Box 398, South Newfane, VT 05351.

Resources for research on related topics:

- National Weather Service offices and meteorologists. Climatological atlases. Utility companies or a state department of energy. Agricultural or forestry extension services.
- See pages L1-L12 "Learner Outcomes" for ideas on additional methods and activities.

Block 8: Forces of Nature: Housing Around the World

Overview

Goals:

1. To have a greater knowledge about world climates and microclimates.
2. To learn what people in other climates do to match their houses to their climates and how they prepare their homes for extreme weather events.
3. To discover how people's lifestyles and housing are affected by the climate in which they live.

Objectives:

1. Familiarize students with the forces of nature that affect different regions.
2. Gather knowledge about how people in different parts of the world build and live according to their climate.
3. Learn about how climates affect people's lifestyles.

Materials:

- references on climate, housing and lifestyles in other regions and countries, including both books and magazines that can be used for collage
- atlases and climatalogical atlases
- world map (reused from block 3)
- weather channel
- art materials for creating pictures of houses from different parts of the world that reflect human response to climate and extreme events
- writing lab or student disks for feedback during the report writing process

Activity Summary:

- Study climatic atlases of the world to identify the forces of weather that affect housing in different regions. LA (R); M (C); S (O) (V); SS (GP) (SR)
- Identify extreme events that affect different world regions. S (I) (V); SS (SR)
- Collect examples of houses from different parts of the world that reflect human response to climate and extreme events, and map the results of your housing study on a world map. LA (S); S (O) (V); SS (CR) (GP) (SR); VA (AP) (MA) (VH)
- Focus individual study of climate and housing on specific regions and countries. LA (R); SS (CR) (GP) (SH) (SR)
- Listen to lectures, slide shows, videos and special presentations about how climates affect people's lifestyles. LA (TS) (L); S (I); SS (SR)

Evaluation:

As a Class

- Map the results of your housing study on a world map, and copy for each student.

Individuals

- Make an oral or written report on climate and housing in a specific region or country, and how climate affects the people's lifestyle. Share the report with the class.
- Compose journal entries with notes and reactions to guest speakers.
- Give an oral book report about a novel from another culture in which climate plays a major role in the characters' lives.

Block 8: Forces of Nature: Housing Around the World
Activities

The previous block pointed out the relationship between housing design and the climate at the site where the house is built. Similar relationships exist between houses and their locations all around the world. Because not all climates are alike, the ways in which houses fit their locations can be very different from place to place. This block offers an opportunity to learn more about the many climates of the world, and to identify some of the many ways that houses match the climate of their location. Some ideas from other regions and climates might provide new ideas for housing design in our own climate.

You may want to review the influences that local resources had on housing, as identified in Block 3. Take another look at the houses from that block, to see if they reflect local climates in addition to local resources.

1 Identify world climate zones using an atlas. For example, tropical (hot and humid or wet), desert (hot and arid), Arctic, temperate.

2 What have people around the world done to match their houses to their climates? Collect examples of houses worldwide that are adapted to the climates where they are located. Choose a particular country and explore how housing there reflects climatic conditions by doing research and inviting guest speakers to talk to the class about climate and housing. Revisit the map your class made in Sources and Resources: Housing Around the World and see if the housing styles you identified reflect the climate of the region. Add the results of your study in this block to the map.

3 Name examples of extreme events (forces of nature). Here are a few to get you started: Hurricanes, Tornadoes, Earthquakes, Blizzards (high snow loads), Floods/ Mudslides.

4 What have people done to prepare their houses for extreme weather events? Collect examples of adaptations and add them to your world map.

5 How do climates shape people's lifestyles? Think about how the climate affects or determines:

How people earn a living
How much time they spend outdoors/indoors
What they spend time doing
What they eat, wear, and possess

6 How do people adapt their housing to reflect their lifestyles?

Nomadic/Temporary/Portable

Number of rooms
Space inside/space outside
Storage space

Block 8: Forces of Nature: Housing Around the World
Instructor's Resource Notes

Examples of the forces of nature that affect housing in different regions

floods
hurricanes
monsoons
tornadoes
earthquakes
volcanoes (lava and ash)
blizzards (snow loads)
tidal waves
extreme heat
extreme cold
mudslides
wind
insects

Housing styles that reflect response to forces of nature

- houses on stilts in flood areas let water flow beneath in flood times
- steep roof pitches in mountainous areas where snowfall is heavy, to shed snow from roofs
- no basements or crawlspaces in areas where groundwater is high
- historic Northern European farmhouses were built above the barn, so heat rising from the animals could warm the house above
- shutters on windows to protect them from hurricanes or high winds
- houses with thick walls provide thermal mass that moderates temperature swings in areas with cold nights and hot days
- enclosed porches and passages to garage and barns protect people from the cold in northern climates
- screens on windows and doors keep out insects
- strong ties between structural components and slightly flexible materials are used in earthquake-prone areas
- in some areas prone to annual monsoons or other violent storms, people build "disposable housing" from abundant materials
- heavily insulated houses in areas of extreme temperatures
- houses designed for passive solar gain in cold climates
- wide overhangs and shading to protect houses in hot climates from the sun

Examples of lifestyle influence by climate

- siesta–in hot, sunny climates people take a break from work at midday to avoid the sun, and resume work when the air cools
- seasonal migration–in areas where the climate is extreme, communities or families may use one area in the summer and move to a more protected area or lower elevation for winter. In hot climates, people may move to higher elevations to avoid summer heat. People may also migrate to find vegetation for their animal herds, moving them as the seasons change and fodder is available. Hunting cultures follow the seasonal migrations of wild animal herds.
- indoor/outdoor activities–in areas where there is a wide fluctuation between seasons, people's lifestyles may change according to the season. In winter they spend more time indoors. They spend more time outdoors during the summer. Certain activities are linked to one season or the other. Agricultural lifestyles are especially influenced by seasonal change, as climate governs planting time and harvest time. Where there is a "rainy season" travel and other outdoor activities are delayed until the rains end.

- agriculture–the climate determines whether cultivating food crops is possible. Some areas are too hot or too dry to grow food. Other areas are too cold, or have too short of growing season. In these places people must produce food by other means, such as herding animals, hunting, fishing or gathering wild plants for food.

Examples of how housing reflects lifestyles

- portable housing–cultures that follow wild or domestic animal migrations need portable housing, or perhaps two houses at opposite extremes of the migration route.
- house size–in cold or rainy climates houses are larger to permit indoor activity. In very cold climates, most houses are large enough to provide indoor activity, but small enough to make them possible to heat efficiently.
- storage space–house size is also related to the number of possessions a family has. In some cultures people own few material goods, or the possessions they do have aren't stored inside. In other cultures people acquire many material possessions and build houses large enough to hold them all. Storage space can also be a sign of life in a climate with distinct seasons. Equipment used during one season of the year is stored during the rest of the year. Root cellars are used to create storage space that remains at a steady cool temperature all year.

Resources for research on related topics:

- Climatological atlases. Encyclopedias. National Geographic. Exchange students or immigrants.
- Five Degrees of Conservation: A Graphic Analysis of Energy Alternatives for a Northern Climate. Lance La Vine, University of Minnesota School of Architecture. University of Minnesota Press. 1982.
- Dwellers in the Land: The Bioregional Vision. Kirkpatrick Sale. Sierra Club Books: San Francisco. 1985.
- See pages L1-L12 "Learner Outcomes" for additional ideas about methods and activities for this block.

Block 9: Energy: Operating and Embodied
Overview

Goals:
1. To learn about renewable and non-renewable energy sources.
2. To make a distinction between operating and embodied energy.
3. To influence consumers to conserve energy.

Objectives:
1. Identify sources of energy and their applications.
2. Introduce the ideas of embodied energy and operating energy.
3. Relate student activity with energy consumption.
4. Identify and implement energy conservation measures in our school and home.

Materials:
- calculators
- references on energy efficiency in construction and operation of buildings
- resources on the production and transmission of energy

Activity Summary:
- Identify a variety of energy sources and relate them with the types of energy they can produce. LA (TS); S (E/M)
- Trace the energy pathway from resource to consumer. S (C) (E/M); SS (PE)
- Identify strategies for operating energy conservation and create a plan for implementing energy conservation measures in your school. LA (W); M (R) (CN); S (E/M); SS (PE)
- Differentiate between operating and embodied energy, and practice calculating embodied energy. M (PS); S (E) (E/M)
- Practice math skills related to energy consumption and transmission. M (PS) (R) (CN); S (E/M)
- Research and write about the process of energy conversion and consumption and its environmental impacts. LA (W) (R); S (C) (I) (E/M); SS (TC) (PE)

Evaluation:
As a Class
- Discuss many and varied strategies for operating energy conservation. Add ideas to the class portfolio.
- Create a plan for implementing conservation measures in your school and present it to the school administration.

Individuals
- Research and present statistics related to energy consumption and transmission.
- Present a paper or skit about the process of energy conversion and consumption and its environmental impacts.
- Add up the embodied energy of a simple object or create a web diagram showing the energy inputs of each constituent which add up to the energy embodied in a complex object or a building. Display these webs in a showcase or wall in the school.
- Write a research paper on the natural processes of the earth which create energy sources and realize the environmental effects of extracting and using those sources.

Block 9: Energy, Operating and Embodied
Activities

How many times each day do you flip on a light switch? Do you ever think about where the energy for lighting, radios, TV, refrigerators and other appliances comes from? Most of the energy we use in homes, schools and offices comes from a long distance and undergoes changes in form. There are many different sources and several different types of energy. Understanding where energy comes from helps us understand how energy production changes the environment, and why it is important to conserve energy.

Operating energy, or the energy used to light, heat and cool buildings, isn't the only type of energy used in a building. The materials used in the building itself–the pieces that make up the walls, roof and floor– took energy to produce. The energy involved in harvesting or mining materials, processing them, transporting them and installing them, is called **embodied energy**. This block will help you become familiar with the sources of energy, and the difference between embodied and operating energy, and identify and implement energy conservation strategies.

1 1. What different kinds of energy are there? (i.e. human energy, electricity, combustion) What activities consume energy?–List.

What are the different fuels used to produce energy? Name both renewable and nonrenewable fuels.

Once again, embodied energy is the energy used to extract, process, transport and install materials. Operating energy is the energy that heats, cools, lights and otherwise powers a building.

2 Give examples of both kinds of energy use in your school.

3 Follow the pathway of operating energy to your school and/or your home. Relate electrical power to the original source of energy. Identify the source of fuel for your local power company. How is energy generated? Draw a flow chart that illustrates the energy pathway. How can energy escape on the way to your home? Contact your local power company and see how it creates energy. Does the fuel used change by season? How do they plan to derive energy in the future, if demand rises? What actions have they taken to help people conserve energy (embodied or operating)?

(Option) Find the percentage of energy lost during transmission of electrical power from the power plant to your school.

4 Access the utility bills for your school. How can the amount of operating energy that it consumes be reduced?

Moderate temperature settings–how can comfort be maintained?
Advances in lighting–daylighting, compact fluorescents, motion detectors
Other conservation measures?

Project how much the school could save by conserving energy in various systems in the building. Create a plan for implementing conservation measures in your school and present it to the school administration.

5 Add up the embodied energy of a simple object or create a web diagram showing the energy inputs of each constituent which add up to the energy embodied in a complex object or a building.

6 Think about the embodied energy of your school building. Where did the materials to make it come from? How were they harvested or mined? How were they processed? How did they travel to the building site? How were they installed?

7 (Grades 9-12) Discover the natural processes of the Earth which create energy sources and realize the environmental effects of extracting and using those energy sources. Write a research paper on a related topic.

Block 9: Energy, Operating and Embodied
Instructor's Resource Notes

Examples of energy sources and the types of energy they produce

Food-metabolic energy (heat and mechanical)
wood-combustion heat energy
biofuels-combustion heat energy
solar-heat and electricity
wind-electricity
hydro-electricity or mechanical
geothermal-heat and electricity
nuclear-electricity
fossil fuels-combustion heat energy

An example of an energy pathway

Coal is mined with a dragline in Wyoming, and trucked in large trucks to a crusher. It is then loaded by conveyor into a silo, and from there it is loaded onto a train and hauled to a power station, which could be as far away as Texas. Coal is unloaded from the train and stored until needed. Coal is burned to generate heat. This heat changes water to steam. Steam powers turbines that generate electricity. The electricity is carried via power lines to substations and smaller lines, and eventually to individual houses and appliances within those houses. Students can research the by-products and emissions generated during this process.

Some strategies for energy conservation

- install efficient furnaces and water heaters
- conserve hot water by using efficient shower heads and faucet aerators
- compact fluorescent lightbulbs to replace incandescents
- turn down heat
- turn off lights not being used
- install motion detectors in hallways, to power lights only when someone is present
- weatherstripping around doors and windows
- install supplemental insulation in buildings

Sample of embodied energy identification

A school desk's components are mainly steel and wood. Iron ore is mined with heavy machinery and transported by large truck or train to a mill where it is pelletized, then fired in a blast furnace at 2500° F with coal, and materials are added for strength and durability, creating steel in a very energy-intensive process. The steel casting is then put in a reheat furnace, where it is milled into rolls, bar, or rods. These steel forms are transported by truck to a plant where they are forged into the shape of desk legs, then transported again to a finishing plant where they will be combined with desktops.

Trees are cut from an area with heavy machinery, then transported by truck to the mill. There the bark is removed and the tree is either cut by a sawmill into dimensional lumber or is "peeled" to make veneers. Scraps, and sometimes whole trees, are chipped into small pieces. Chips are shipped by truck or train to a mill that specializes in particle board production, and is powered by both steam and electricity. That mill refines the chips into small particles, and dries the particles in a flash dryer. Oils and resins are added to form the board, which is then put in a heavy press. The final panel is stabilized and dried again. In the case of most desk tops, veneers are laid on the top and bottom of particle board pieces and glued together using a heavy press and heat produced by burning sawdust. The desktop is coated with a synthetic finish that resists wear. Then the desktop is shipped to the finishing plant and assembled with the steel legs using steel screws. Metal alloy feet are attached to the legs. The desks are packaged in cardboard made from wood fibers and shipped by truck to a distributor. Desks are shipped out regionally to school district warehouses, and from there to individual schools.

Each transportation step consumes fossil fuels. Each processing step uses energy to convey the raw material, run the equipment that handles it, and power the machinery that changes its form. The energy total has to include the energy in creating any paint or varnish applied to the desk, the energy in the fasteners and adhesives that hold the pieces together, the energy used to light and heat the plant where each component is made, and even the energy required to maintain it through its use and take it apart when it can no longer be used as a desk.

If the desk has any plastic or rubber components, these add their own embodied energy to the total.

Possible research paper topics

- Origin and supplies of fossil fuels
- Debate over oil extraction in ANWAR
- Acid rain
- Strip mining impacts
- Hydroelectric dam construction
- Hydroelectric project impacts on fisheries
- Nuclear waste
- Impact of oil drilling and/or oil transportation and spills

Sources of more information

- Montana Power Company offers a Guide to Educational Resources that is a catalog of free resources for K-12 and adult educators. Many resources deal with electricity production, but others deal with alternative energy and energy efficiency. Materials available include printed publications, videos and posters. The Guide contains order cards for available items. Montana Power Company, Public Safety and Education, 40 East Broadway, Butte, MT 59701, phone (406) 723-5421.
- Energy Efficiency and Renewable Energy Clearinghouse (all information free of charge; offerings include educational materials) Tel: (800) DOE-EREC or by e-mail at energyinfo@delphi.com

Resources for research on related topics:

- Information from your local power company.
- "Home Energy: The Magazine of Residential Energy Conservation," 2124 Kittredge St., #95, Berkeley, CA 94704 Tel: 510-524-5405
- "Conservation Monitor" (on-line magazine) NewsData Corporation, P.O. Box 900928, Seattle, WA 98109-9228
- Rocky Mountain Institute, 1739 Snowmass Creek Rd, Snowmass, CO 81654-9199, phone 970-927-3851. Publications and information on improving industrial and residential energy efficiency and implementing alternative energy systems.
- Building on Success: The Age of Energy Efficiency. Christopher Flavin and Alan B. Durning. Worldwatch Paper No. 82, March 1988.
- Regional Guidelines for Passive Energy Conserving Homes. AIA Research Corp. for the US Department of Housing and Urban Development. Superintendent of Documents: Washington. July 1980. HUD-PDR-355(2).
- Consumer's Guide to Energy Savings. Alex Wilson and John Morril. Council for an Energy Efficient Economy: Washington, D.C. 1991.
- See pages L1-L-12 "Learner Outcomes" for additional ideas on methods and activities.

Block 10: What's New with Renewable Energy
Overview

Goals:
1. To familiarize students with available renewable energy sources.
2. To assess the feasibility and application of these energy sources in our region.

Objectives:
1. Review sources of energy people use in our town and how they are used.
2. Explore what different renewable energy sources are used in the world.
3. Evaluate the options for using renewable energy in our community.

Materials:
- calculators
- references on renewable energy generation and use

Activity Summary:
- Review types of energy and energy sources, and identify renewable sources. S (V) (E/M); SS (TC)
- Investigate actual and potential use of renewable energy in the community, and the environmental impacts this causes or prevents. LA (TS); S (I) (E/M); SS (TC) (PE)
- Practice math and physics skills related to solar and wind power generation and consumption, including establishing priorities for energy use. M (PS) (R) (CN); S (E/M)

Evaluation:
As a class
- In small groups, evaluate the options for using renewable energy in our community. Then, investigate actual and potential use of renewable energy in the community. One person acting as reporter should read his or her group's results to the class.
- Hold group discussion on the impacts of renewable and nonrenewable energy use.

Individuals
- Assess the feasibility and application of renewable energy sources in our region by presenting to the class various examples you think can work here.
- Make a chart of priorities for your home's energy use. Note which can or cannot be supported by solar and wind power. Note how much energy it takes to run each item on your chart. Preserve chart and analysis in student portfolio.

Block 10: What's New with Renewable Energy
Activities

The previous block looked at many types of energy and sources of energy. This block focuses on renewable energy, and the alternative it presents to conventional fossil fuel energy. Use of energy from renewable sources is becoming more common. Large utility companies are beginning to use a little energy from renewable sources, but most renewable energy use is on a small or individual scale.

Because small-scale renewable energy equipment is limited in the amount of power it can produce, people who depend on renewable energy sometimes have to decide which uses are most important. This provides a good opportunity to think about how much energy appliances use, and how each of us would choose to use energy if our supplies were limited.

1 Refresh your memory on types of renewable energy: solar, wind, hydro and biofuels, as well as human and animal energy. What impacts does use of renewable energy have on the environment? What impacts are avoided through substitution of renewables for non-renewables?

2 Do you use renewable energy at home or at school?
What are some possible uses for renewable energy?

Water heating
Space heating
Vehicle power
Electricity
Tool powering (through steam production, force transfer, etc.)

3 Who uses renewable energy in your community? How do they derive it? What is the legislative history of support for renewable energy?

4 Is your community suited for additional uses of renewable energy?

What wastes are available from industry in your community for use as biofuel?
What is the insolation for your town? (Number of sunny days and hours of daylight)
What is the average windspeed and direction at your location?
Are there geothermal features nearby?
What is the average ground temperature?
Where is the nearest body of water? Is it developed for hydropower?

5 How many 100 watt/hour solar panels and batteries would it take to run your TV for 6 hours? (Assume a 25" color TV, which consumes 150 watt/hour). What if you added a VCR (at 40 watt/hour)?

6 If you owned ten 100 watt panels and batteries to power your home on a late spring or early summer day with 8 hours of insolation, how much power would you generate, and how would you use it? Which electric and electronic devices would you run and for how long? How would you accomplish other tasks, once you ran out of solar power? What would you do on a cloudy day, or a winter day with only 3 hours of insolation?

Here are the approximate power consumptions of some typical appliances:

	Watts/hr		Watts/hr		Watts/hr
Coffee maker	800	Iron	1000		
Toaster	800-1500	Vacuum cleaner	200-700	Lights (incan)	
Popcorn popper	250	Ceiling fan	10-50	100w	100
Blender	300	Washing machine	500	75w	75
Microwave	600-1500	Clothes dryer (gas powered)	4000 (300-400)	Lights (compact fl.)	
Frying pan	1200	Blow dryer	1000	40 w equiv	11
Dishwasher	1200-1500	Computer (printer)	80-150 (100)	60 w equiv	16
Furnace blower	300-1000	TV 25" (color) (19" color)	150 70	100 w equiv	30
Refrigerator (15 hrs)	540	VCR	40	75 w equiv	20
Freezer (15 hrs/day)	440	Stereo	10-30		
Electric clock	3	CD Player	35		

7 Pretend you have an average wind speed of 10 mph and at that speed your wind turbine will produce 720 watts per hour. How many 75-watt incandescent light bulbs can you run at one time while the wind is blowing? A 20-watt compact fluorescent is equivalent to a 75-watt incandescent. How many of them can you run at once?

(Option) Calculate the angle at which solar panels should be placed for maximum solar gain at your latitude.

Block 10: What's New with Renewable Energy
Instructor's Resource Notes

Renewable energy sources
- sun
- wind
- water (including tidal energy generation)
- sustainable use of agricultural fibers and/or wood
- geothermal
- methane gas from composting or animal manure
- animal energy (draft animals can power machinery)

Some impacts of renewable energy production
- burning wood and other agricultural wastes can cause particulate emissions
- equipment to make use of renewable energy sources is often expensive
- solar panels require a lot of space to generate large amounts of electricity
- equipment to make use of renewable energy sources takes a great deal of energy to produce, and requires expertise to install and maintain
- some people think "wind farms" have a negative aesthetic impact
- large scale hydropower development affects fisheries and riparian habitats
- use of draft animals can degrade the land where they are kept

Impacts that are avoided by substituting renewables for non-renewables
- renewable energy generally causes less air pollution
- renewable energy use doesn't produce hazardous wastes
- impacts of strip and underground mining or oil drilling are avoided
- renewable energy is easier to produce on a small scale and at remote locations. This prevents transmission losses, and the impact of large power stations and power lines.
- renewable energy use (except for biofuels) doesn't add as much carbon dioxide to the atmosphere as use of fossil fuels, and doesn't contribute to acid rain

Examples of potential uses for renewable energy in homes
- passive or active solar heating
- PV (photovoltaic) solar water heaters
- PV (photovoltaic) electricity
- windmill for energy production or water pumping
- micro-hydro power systems for electricity creation
- burning wood for heat
- composting biomass for heat
- charging electric autos

Examples of potential uses for renewable energy in communities
- photovoltaic power stations
- biogas (methane and ethanol) production from agricultural waste
- windmill "farms" for electricity production
- PV collection and storage facilities as recharge stations for electric automobiles
- geothermal steam to power industrial processes
- mechanical force of water or draft animals to power tools or equipment
- coastal communities can use tidal power to generate electricity for industry

Sources of additional information on renewable and alternative energy

- Montana Power Company offers a Guide to Educational Resources that is a catalog of free resources for K-12 and adult educators. Many resources deal with electricity production, but others deal with alternative energy and energy efficiency. Materials available include printed publications, videos and posters. The Guide contains order cards for available items. Montana Power Company, Public Safety and Education, 40 East Broadway, Butte, MT 59701, phone (406) 723-5421.
- Energy Efficiency and Renewable Energy Clearinghouse (all information free of charge, offerings include educational materials) 1-800-DOE-EREC or via e-mail at energyinfo@delphi.com, or at the Energy Efficiency and Renewable Energy Site http://www.eren.doe.gov. They also offer a CD-ROM multimedia encyclopedia on renewable energy, called The Sun's Joules. There is also a world wide web version at http://solstice.crest.org/.
- Rocky Mountain Institute, 1739 Snowmass Creek Rd, Snowmass, CO 81654-9199, phone 970-927-3851. Publications and information on improving industrial and residential energy efficiency and implementing alternative energy systems.

Notes on renewable energy story problems

A solar panel produces 100 watts per hour in full sunshine. A 25" color TV takes 150 watts per hour, so running it for 6 hours would take 900 watts. Adding a VCR at 40 watts per hour for 6 hours brings the total to 190 watts per hour, or 1140 over 6 hours. This can be managed with two solar panels, provided that there are six or more hours of full sunshine per day.

The 8,000 watts provided by the 10 panels can be divided as students choose. One way of lessening requirements for electricity is to change to major appliances powered by propane, like the refrigerator and clothes dryer. Heating and air conditioning are usually not electric in a solar home.

The wind turbine would power 9 incandescent bulbs at once, or power 36 compact fluorescents to produce an equivalent amount of light.

Resources for research on related topics:

- Real Goods- Solar Living Sourcebook or The Independent Home. Can be ordered through Real Goods, 966 Mazzoni St., Ukiah, CA 95482-3471, Tel 800-762-7325 fax 707-468-0301.
- National Renewable Energy Laboratory (NREL). Write PV Program 1617 Cole Blvd., Golden, CO 80401-3393. Offer information and a quarterly publication.
- Home Power magazine (800) 707-6585.
- on-line newsgroup alt.solar.thermal
- American Solar Energy Society, 2400 Central Ave., Unite B-1, Boulder, CO 80301.
- American Wind Energy Association, 777 N. Capitol St. NE, Suite 805, Washington, DC 20002.
- Northeast Sustainable Energy Association, 23 Ames St., Greenfield, MA 01301.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities for this block.

Block 11: Doing More With Less
Overview

Goals:
1. To have students realize that quality and quantity can function independently in building design.
2. To establish the relationship between design and strength.
3. To learn about space efficiency in building.

Objectives:
1. Focus building design with the intention of using less resources, but keeping the integrity and function of the structure intact.
2. Relate strength with design by creating efficient structures which perform effectively.
3. Contrast how large and small buildings employ resources to provide space.

Materials:
- toothpicks, rubber bands, cardboard and other reused materials for model building
- references on building design
- graph paper, drafting tools, or CAD programs if available
- calculators

Activity Summary:
- Design simple structures using elements of design to support the most weight with the fewest structural materials. M (R) (G); S (C) (O) ; VA (AP) (C) (MA)
- Identify desirable amenities in houses or schools, then learn about space efficiency and the principles of employing it in design by drawing floorplans that functionally include these amenities within a given space. M (R) (CN) (G); S (T/S); SS (TC) (SR); VA (C) (MA) (V)
- Perform calculations and conduct interviews to establish material and energy savings possible through efficient design. LA (L); M (PS) (CN); S (T/S)

Evaluation:
As a Class
- Present calculations for material and energy savings possible through efficient design.
- Invent a game which has the players design structures that use few materials to support weight. [folding paper so that it supports a heavy object, or designing a structure out of toothpicks, etc., with the fewest number of pieces to support the heaviest weight.]
- Arrange an exhibit of floorplans developed by class members. Videotape the exhibit and keep an edited copy in the class portfolio.

Individuals
- Create simple structures using elements of design to support the most weight with the fewest structural materials.
- Identify desirable amenities in houses or schools, then draw functional floor plans that include your desirable amenities in the least possible space. Display the class' floor plans on the gym floor and invite the rest of the school to tour your work.

Block 11: Doing More with Less

Activities

In some games, players build a house of cards or a tower of blocks and then remove them one by one until it falls. We don't want to have buildings that fall, but often buildings could be built with less material and still be very sturdy. One way to do this is to trap air: foam, autoclaved cellular concrete. Another way is to use weak materials in configurations that make them stronger: accordion pleat paper and wood fiber, trusses, honeycomb cells. Or you can add strong glues to make bigger pieces out of smaller ones: engineered wood, recycled rubber matting.

Another way to do more with less is to use space efficiently. With careful planning, one space can effectively serve many purposes. This means that a smaller building that contains fewer materials and uses less energy can do the same job as a larger building. This block provides the opportunity to practice space efficiency by designing houses that include important features in a small amount of space.

1 Allot each student an equal amount of "building supplies" such as toothpicks, rubber bands, paper clips, sheets of paper, or other objects. Hold a challenge to see who can create the structure that uses the least materials to support the greatest weight. How did the winning structure apply materials? Does the way the materials are grouped and the design of the structure affect its strength?

2 Identify the amenities you would want in a house. Here are just a few examples: sunroom, built-in dishwasher, computer station.

Now, if you have 1200 square feet to work with, draw a floorplan for a house for you and your family, including the components a house needs and the amenities you want. Are you going to have trouble fitting everything in?

There are several ways to make houses more **space efficient**. One is to design multi-purpose spaces that can serve for more than one function. For example, a family room might serve as a guest suite, or a corner of the living room as an office. Built-in storage in underutilized spots can also help make rooms serve more purposes with less clutter. Eliminating wasted space in hallways and little-used rooms is another way to gain space efficiency.

Have fun designing your floorplan! Remember to include space for necessary things like stairways and heat sources in your 1200 sq. ft. plan.

3 If you use framing studs 24" on center rather than 16" on center, approximately how much less wood do you use? If the average house uses 12,000 board feet of lumber, how much wood is saved by switching to 24" framing? What other safe, efficient building practices could you use in a new building? Interview a carpenter to learn about current practices and possible alternatives.

Block 11: Doing More With Less
Instructor's Resource Notes

Design principles that provide strength with few materials
Arches
Trusses
Tensioning

Principles of space efficiency
Multi-purpose spaces
Built-storage spaces
Reduction in hallway space
Long views through a small space
Open floor plans to promote feeling of spaciousness

A sampling of amenities to include in structures

TV room
Dishwasher
Closet space
Porch/Deck
Garage
Exercise room
Windows
Guest bedroom
Washer and Dryer
Bedroom
Basement
Greenhouse
Den/study
Computer station
Dining room
Playroom

Make sure these aspects are also included in the allowed space

Furnace or heating system
Hot water system
Refrigerator
Bathroom
Stairs in 2 story house
Kitchen/ cooking facilities
Doorways
Storage

Using studs 24" o.c. rather than 16" o.c.
Approximately a 33% savings of dimensional lumber is achieved by using advanced framing, although savings can vary by the shape and layout of the actual house. This strategy also provides more space for insulation within the wall cavity, allowing the house to be more energy efficient.

Resources for research on related topics:
- Making Space: Design for Compact Living. Overlook Press, Lewis Hollow Rd., Woodstock, NY 12498.
- Small Home Plans. The Garlinghouse Company, P.O. Box 1717, Middletown, CT 06457.
- Small Houses. Tauton Press, Box 5506, Newtown, CT 06470-5506.
- Small Houses of the Next Century. McGraw Hill.
- Many other books on small houses, tiny houses and compact house designs, available at libraries or bookstores.
- See pages L1-L12 "Learner Outcomes" for ideas on additional methods and activities for this block.

Block 12: Alternative Materials
Overview

Goals:

1. To investigate resource efficient materials used in building.
2. To discover how people build with unconventional materials.
3. To explore how technology allows building materials to be more resource efficient.

Objectives:

1. Disseminate information about indigenous materials, engineered lumber and building products from agricultural waste.
2. Research how using innovative materials and technologies places less stress on our region and on global ecosystems.
3. Evaluate the potential for resource conservation through the use of alternative materials in building construction.

Materials:

- resources which give examples of indigenous materials, engineered lumber and building products from agricultural waste
- computer that provides Internet access

Activity Summary:

- Explore options for alternative building materials, through field trips, and group and individual research on materials. LA (R) (L); S(I); SS (SH) (SC); VA (AP) (VH)
- Use math skills to calculate energy and resource savings possible through the use of alternative materials. Become familiar with the idea of life-cycle costing. LA (TS); M (PS) (R) (CN) (G); S (E/M)

Evaluation:

As a Class

- Divide up topics to research in your small groups: materials, energy savings from calculations on the use of alternative materials, the cost of metal roofing versus cedar shakes over the lifetime of the house. Compare up front costs to operating costs over the life of the building. Each group can present life cycle cost results. Write these up and use graphs to illustrate your findings. Present to the class.

Individuals

- Research alternative building materials and report on your findings.
- Identify alternative buildings in your town or area and arrange field trips to experience them firsthand. Write in your journal about your reactions to these structures and the methods used to build them.
- Write an outline of all the areas visited. Draw a map of the excursions and add to student portfolios.

Block 12: Alternative Materials
Activities

One way to conserve natural resources is to build structures that use fewer resources. Another is to build out of materials that are common and abundant, yet provide comfortable houses that don't require extra energy to build or operate. Some examples are: adobe, strawbale, earthships, stone, rammed earth, earth block. These are often called **indigenous** materials. Do you know anyone who lives in a house made of alternative materials?

Other alternative materials can be salvaged and reused materials, like the ones discussed in Block 5, or new materials like the ones you designed in Block 2, or materials that do more with less, like the engineered products mentioned in Block 11. This block encourages you to identify a range of alternative materials and learn more about them, and then experience structures made from these materials.

1 Research alternative building materials and systems. Try books and periodicals at the library, and, if you have access, the Internet. The Resource Notes for this lesson suggest some Internet sources of information.

2 Identify alternative buildings in your town or area and arrange field trips to experience them firsthand. Write about your reactions to these structures and the methods used to build them.

3 Use of alternative building materials can help conserve energy and prevent pollution. For example, if you use adobe stucco to cover a 14' x 8' wall, how many tons of CO_2 production from cement making are avoided?

4 How many times longer does metal roofing last then cedar shakes? Linoleum than carpet? Figure the cost of metal roofing versus cedar shakes over the lifetime of the house. Do the same for flooring. Which material costs more initially? Which costs more over the lifetime of the structure? What are the expected lifetimes of structures built with alternative materials?

Block 12: Alternative Materials

Instructor's Resource Notes

Examples of indigenous building materials

sod
log
stone
earth-adobe and rammed earth
straw-bale or straw/clay or cob
thatch

Examples of other alternative building materials

bamboo
tires (Earthships)
bottles
cordwood masonry

Sources of information on alternative building materials

- Internet

Newsgroup alt.architecture.alternative
Bamboo web page http://www.halcycon.com/p1rabbit/bamboo/abs.html
Strawbale Construction Web Information page http://solstice.crest.org/efficiency/straw_insulation/index.html
Strawbale list archives http://solstice.crest.org/efficiency/strawbale-list-archive/index.html
Hay Bale Construction Party http://solstice.crest.org/efficiency.straw_insulation/eip/hay.html
List of Balers http://solstice.crest.org/efficiency/straw_insulation/list_members.html
Strawbale page http://www.xmission.com/~shea
Earthship web page http://www.slip.net/~ckent/earthship

- House of Straw, a free publication available from EREC, 800-DOE-EREC or e-mail energyinfo@delphi.com

Notes on up-front cost, environmental and energy cost, and lifetime cost analysis

A better way to look at the "true cost" of a product or material is through a process called life cycle analysis. A way to look at this is to compare a compact fluorescent bulb with a traditional incandescent bulb. One regular 75 watt light bulb costs about $.75, while a 20 watt CF produces the same amount of light and costs about $20. You need 12 incandescent bulbs to produce 12,000 hours of light but you only need one CF to produce the same amount of light. Since 12 incandescent bulbs are needed to equal the longevity of one CF, the incandescent bulbs will cost $9 over the life of one CF. The energy cost for 12,000 hours of light for an incandescent is $72 ($.08 per Kilowatt hour X 12,000 hours X .075 kW per bulb), and the energy cost for a CF is $19.20. Add the energy costs to the cost of the bulbs. Over a lifetime, the incandescent bulb costs $81 and the CF $39.20. The CF saves you $41.80 over its lifetime!

A look at life-cycle costs makes one realize that the up-front cost does not always reflect true prices and savings over the lifetime of the material.

Resources for research on related topics:

- Center for Resourceful Building Technology, P.O. Box 100, Missoula, MT 59806.
- Center for Maximum Potential Building Systems, 8604 FM 969, Austin, TX 78724.
- EPA. Life Cycle Assessment: Public Data Sources for the LCA Practitioner. From the National Technical Information Service.
- Earth Sheltered Community Design: Energy Efficient Residential Development. Underground Space Center, University of Minnesota. Van Nostrand Reinhold. 1981.
- Gentle Architecture. Malcolm Wells. McGraw Hill: NY. 1991.
- Earthship I, II, III. Earthship Global Operations, P.O. Box 2009, El Prado, NM 87529. E-mail earthshp@interserv.com.
- See pages L1-L12 "Learner Outcomes" for additional methods and activities for this block.

Block 13: Healthy Houses, Healthy Lifestyles

Overview

Goals:

1. To draw a correlation between indoor lifestyles and our health.
2. To alert students about the possible health effects of modern building practices and materials.

Objectives:

1. Investigate and assess indoor and outdoor environments.
2. Analyze how buildings influence daily activities.
3. Create interest in avoiding toxic materials in building our homes.
4. Promote an awareness of how to achieve good indoor air quality.

Materials:

- computer or pencil and paper graphing supplies
- writing lab or student disks so the teacher can use his or her classroom computer to read drafts of papers through the writing process
- experts with equipment to test indoor air quality

Activity Summary:

- Graph and chart activity patterns to find the amount of time spent indoors and time spent actively. M (C); S (T/S)
- Learn about health concerns related to building materials, including indoor air quality. LA (R); S (E) (I) (O); SS (SR)
- Diagnose the possible sources of toxins and other pollutants in our school and homes, and work with a professional to assess indoor air quality of the school. LA (L); S (C) (I) (O)
- Make a plan for mitigating any identified problems with your school's indoor air quality. LA (TS); M (C) (CN); S (C) (I) (O) (V); SS (SC)
- Write a research paper on the relationship between health and building materials. LA (W)(R) (TS); M (C); S (C) (E)

Evaluation:

As a Class

- Present an assessment of indoor air quality of the school to the administration or school board.
- Create a plan for mitigating any identified air quality problems.

Individuals

- Graph lifestyle habits and time indoors/outdoors, and write journal responses to the graphs.
- Write a research paper. Discover the physiological effects of toxins, pollutants or indoor living. Include a final draft of papers in student portfolios.
- Give an oral book report on a nonfiction book about air quality, building materials, or toxic materials.

Block 13: Healthy Houses, Healthy Lifestyles

Activities

Studies show that people spend much more of their time indoors than they did fifty or even twenty years ago. This changes the kind of activities people do, and it can also affect their health. When people spend more time indoors, the quality of indoor air becomes a more important concern. Indoor air can be polluted with toxins from sources that we might not suspect. Building materials and furniture can contain volatile organic compounds (VOCs), formaldehyde, or other irritants. This block will help to identify some possible sources of indoor air pollution, and encourage you to find ways to improve the quality of the indoor air you breathe.

1 List your 5 favorite activities. Are they performed indoors or outdoors? Are they physically active or passive? Chart your activities for 3 days. Include what you eat, how much you sleep, how much you exercise and your other activities. Analyze the time spent indoors and compare to the amount of time spent outdoors. Compare the amount of time spent in physically passive activities to that spent in active pursuits. Identify ways to improve the healthiness of your diet and lifestyle.

2 Talk about toxins in building products. Identify the "worst" products to use. Think of alternatives to using these products.

3 Diagnose the possible sources of toxins and pollutants in your school and home, then invite professionals to test the indoor air quality (IAQ) of your school. Make a plan for mitigating any identified toxins or pollutants.

4 (Grades 9-12) Write a research paper. Discover the physiological effects of toxins, pollutants or indoor living. Present your findings to your class, suggesting possible solutions to the problems you researched.

Block 13: Healthy Houses, Healthy Lifestyles
Instructor's Resource Notes

Health concerns related to building materials

allergies
nausea
cancer
multiple chemical sensitivity
asthma and respiratory problems
dizziness
headaches

Sources of toxins and indoor air pollutants

Materials

- urea formaldehyde glues in particle board, plywood and OSB
- chemical compounds in adhesives used in carpet laying, carpet backing, wallpaper glue and other construction applications
- Volatile Organic Compounds (VOCs) in paints, carpets, and vinyl flooring
- cleaning agents (ammonia or chlorine based products, industrial strength cleaners)

Appliances backdrafting

- A situation in which there is negative pressure in the home as compared to outside. Thus, as an appliance exhausts its combustion byproducts, instead of it venting to the outdoors, the exhaust is actually sucked back into the house by the negative pressure or the intakes on other appliances. The result can be a high release of CO into the home, causing drowsiness, respiratory problems, and in extreme cases, death.

Activities

- smoking
- furniture refinishing indoors, crafts and hobbies using glues and paints
- any activity that produces excessive water vapor, potentially leading to mold growth
- fires in a poorly vented fireplace

Resources available on improving you schools Indoor Air Quality (IAQ)

- "Improving your school's IAQ: A Guide for Preventing ad Resolving Indoor Air Quality Problems". An EPA publication, offering information on typical indoor air pollutants, evaluating indoor air qualities, IAQ management plans, teacher guides and many other helpful steps to better IAQ. Contact the IAQ information Clearinghouse, U.S. EPA, P.O. Box 37133 Washington, DC 20013-7133 Tel: 800-438-4318, 301-585-9020 fax: 301-588-3408. Information specialists are on duty 9-5 eastern time.
- National Institute for Occupational Safety and Health. They conduct research, recommends standards to the U.S. Department of Labor, and conducts training on various issues including indoor air quality to promote safe and healthful workplaces.

Resources for research on related topics:

- The Healthy House and Healthy House Building, both by John Bower of the Healthy House Institute, 7471 N. Shiloh Rd, Unionville, IN 47468.
- Your Home, Your Health, and Well Being by David Rousseau. Ten Speed Press, P.O. Box 7123, Berkeley, CA 94707.
- Healthy Buildings Resource Guide by Dan Morris, Healthy Building Associates, 1932 1st Ave. #515, Seattle, WA 98101.
- See pages L1-L12 "Learner Outcomes" for additional ideas on methods and activities.

Block 14: Population and Development
Overview

Goals:
1. To draw parallels between population growth and resource consumption.
2. To live with less impact on our environment.

Objectives:
1. Compare resource consumption and population growth on a local and global level.
2. Investigate the impact of growth on our community.
3. Examine how changing population dynamics affect a region.
4. Emphasize what effect our consumptive lifestyles have on our environment.

Materials:
- graphing supplies or computer graphing software
- maps of various regions in the city, state, and nation
- writing lab or classroom computer for creative writing and research papers

Activities:
- Study population dynamics. Identify reasons for shifting population. LA (TS); M (CN); S (E) (O) (T/S) (V); SS (CR) (TC) (GP)
- Track the population history of a town, state, region or country over time. Graph and chart population change . M (C) (R) (CN); S (E) (T/S) (V); SS (CR) (GP) (TC) (PE) (SC)
- Establish the relationship between population and the impact of consumption through math story problems related to consumption. LA (W) (TS); M (PS) (C) (CN); S (C)
- Write or create art about how population dynamics personally affect individual lives. LA (W); SS (TC) (SH) (SC); VA (MA) (V)

Evaluation:
As a Class
- Discussion of population and resource consumption.
- Draw graphs on population dynamics, and add these to class portfolio.
- Produce a 15-second public service announcement from your script (see below) to distribute to TV or radio stations around the state.

Individuals
- Write story problems on resource consumption and population.
- Write about how population dynamics personally affect individual lives.
- Draw a storyboard for a script alerting the public to the dangers and effects of overpopulation and overconsumption.

Block 14: Population and Development

Activities

The populations of towns, cities, states and countries are always changing. Sometimes these changes are related to economic or political events. **Emigration** and **immigration** can have significant impacts on the environment in a region. More people need more land for houses, and more people usually cause more pollution. More people consume more natural resources, as well, particularly if they occupy an area for a long time. This block encourages you to explore the relationship between population and consumption, and could help you realize that while your own consumption might not seem significant, when it is multiplied by an entire population it can have a dramatic impact on natural resources and the environment.

1 Identify some causes of population shifts. Think of political causes, economic causes, and environmental causes. Some vocabulary related to this topic includes **migration, boom and bust trends, emigration, displaced persons, refugees**. Consider which of these forces were at work 100 years ago in Butte, MT. How are population shifts like these related to resource extraction?

2 Find the population of your town and/or region and track the dynamics of the population. Graph the population dynamics of your community, your region, and/or the world.

3 Trace the relationship between population growth and natural resource consumption. Here are some examples to get you started:

- If each household in the United States builds a 2,000 square foot house, how many acres of land are covered by houses?
- Figure out how much toothpaste you consume in your life, multiply it by the world population.
- If you use 4 ounces of toothpaste per month, how many pounds will you use in the next 20 years? How many will your town use? The nation?
- If every person uses 8 trees per month, how many trees are cut in a year, nationwide?
- If each person throws out 4 pounds of garbage per day, how much garbage does your town produce in a year?
- Write your own consumption story problem. Can your classmates figure out the answer? Report on the answers, and compile a fact sheet on consumption.

4 Have you ever had friends or relatives move away? Where did they go? Write about the experience, its causes and your response.

Have you ever moved to a new place? What is it like to be somewhere different? What was it like to leave your old home? Write or create art about the experience.

Block 14: Population and Development
Instructor's Resource Notes

Examples of causes for population shifts

Political wars government change	Economic resource discovery resource exhaustion market failure
Environmental extreme season change droughts/climate change crop failure or loss natural disasters chemical or radioactive spills or accidents	Social overcrowding religious divisions racial discrimination

Notes on population and consumption relationship

While the amount of resources each of us consume as individuals may not seem large, the cumulative impact of a nation of consumers is staggering. On a global scale, consumption is even greater, although consumption in the U.S. is disproportionately high. While the population of the United States by no means compares to the most populated regions of the world, our per capita consumption levels are among the highest on the planet. That means that we are consuming more total natural resources and energy than most other countries on earth.

As other nations strive to emulate the American lifestyle, their levels of consumption are apt to rise, with consequent increases in the amount of waste produced, and the rate of depletion of global resources. As the world population continues to increase in the coming years, pursuit of a consumptive lifestyle will have ever greater impacts on the supply of natural resources and environmental quality. Global overpopulation is a complex and controversial issue, but each individual can start by recognizing his or her own contribution to global consumption, and understanding how those individual impacts are multiplied by population increases.

Resources for research on related topics:

- "The Children's Environmental Index" Zero Population Growth, 1400 Sixteenth St. NW, Suite 320, Washington, DC 20036.
- K. Ross Toole's Montana Series or other books on Montana history.
- The Lorax by Dr. Seuss. Almanacs, the Census Bureau, American Demographics magazine.
- Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future. Meadows and Randers. Chelsea Green Publishing: Post Mills, VT. 1992.
- See pages L1-L12 "Learner Outcomes" for ideas on additional methods and activities for this block.

Block 15: Living in a Resourceful World
Overview

Goals:
1. To summarize the blocks of Building Our Children's Future.
2. To challenge students to incorporate resource efficiency into their lives.

Objectives:
1. Plan how to participate in efficient land planning, building design, etc. in your community.
2. Encourage responsible choices as consumers and resource stewards.
3. Foster thought about resource efficiency in all aspects of our lives.

Materials:
- information on environmental groups, local activists, etc.

Activity Summary:
- Predict likely future scenarios based on knowledge of resources, construction, consumption and population during this unit. LA (W) (TS); M (R); S (C) (I); SS (CR) (GP) (TC) (PE) (SC)
- Formulate a challenge to reduce your own consumption, and write a plan to implement it. LA (TS); S (E) (I); SS (SH) (SC)
- Identify ways for people to participate in communities and support causes they believe in. Find ways for the class or students to become involved in political processes, or to support a cause. LA (TS); SS (PE) (SH) (SC)
- Explore career options relating to this unit. LA (L) (R); S (O); SS (SH) (SC); VA (C)
- Bring in guest speakers and ask them questions about what you've learned in this unit and what they do to be responsible consumers and promote their beliefs. Interview groups or organizations to identify examples of activism. LA (L) (S); S (I); SS (GP) (SH) (SC); VA (C)
- Prepare an entry in the "Building Our Children's Future" Design Contest. LA (W) (S); M (CN) (G); S (E) (I) (O) (V); SS (SR) (SC); VA (AP) (MA) (V) (VH)

Evaluation:
As a Class
- Research the missions and histories of activist groups.

Individuals
- Interview individuals who act on their beliefs about the environment and natural resource consumption. Present the results of the interview to the class, and include in students' portfolios.
- Write a journal entry that sets challenges for long and short term actions. Include an action plan and a means of evaluating progress toward goals.

Block 15: Living in a Resourceful World

Activities

In this unit you have explored the relationship between buildings and natural resources. This block gives you a chance to reflect back on what you have learned, and to determine how you can apply the understanding you have gained. It also provides an opportunity to synthesize the previous blocks, and use them in preparing a building design to enter in the "Building Our Children's Future" Design Contest.

1 Write about what you think your town will be like when you graduate from high school. How about when your children graduate from high school? What are the forces which are causing changes in your community? What are the forces creating changes throughout the world?

2 Think of ways to reduce your consumption of natural resources and reduce waste. What are actions you can take now? What will you do in the next year? What is an action you can start now and keep doing for the rest of your life? Set a challenge for yourself to meet for the short-term future and one for the long-term future. Include a plan of how you will meet these challenges, and how you will measure your progress toward achieving these goals.

3 Find examples of how other people have challenged themselves to be responsible consumers. Consider product boycotts, bulk buying and packaging reduction campaigns. How have people challenged themselves to be active citizens in a resourceful world? Find examples of organizations that are politically active in protecting natural resources, either through lobbying or direct actions. Identify careers that promote resource efficient living, and invite some of the people who work in these fields to speak in your classroom. Some people have built resource efficient houses or volunteered for causes they support. Conduct an interview with an individual or group to find out about his or her personal commitment and activism. Share your results with the class.

4 Become active yourself in support of causes you believe in. Join or support organizations that endorse your beliefs. Encourage eligible voters to vote in elections. Campaign for a political issue that furthers your ideas about alternative building practices. You may want to prepare for a career in a field related to these causes.

5 Enter the Building our Children's Future Design Contest. Class members can prepare individual entries and decide as a group which one to send in, or the class can work as a group to prepare a single entry. Additional instructions can be found in the back of the instructor's curriculum packet, following Block 15.

Block 15: Living in a Resourceful World
Instructor's Resource Notes

Examples of ways to participate in community decision-making

- Vote
- Comment on Environmental Impact Statements produced by federal agencies
- Testify at congressional hearings
- Attend meetings of city and county government
- Circulate petitions
- Write letters to the editor of local or regional newspapers
- Talk to others about the issues that concern you

Career options related to this unit

Architect/ Draftsperson
Building inspector
Building material manufacturer
Building materials researcher
City planner
Demolition contractor
Engineer–mining, petroleum, civil, structural, environmental, waste
Forester
Interior designer
Landscape architect
Plant breeder or seed distributor
Restoration ecologist
Biologist
Builder/remodeler
Building materials distributor
Building materials retailer
Demographer
Economist
Farmer
Industrial ecologist
Land/water reclamation
Marketer
Politician
Recycler/ materials recovery industry

Some examples of individual actions for reducing consumption

- Buy bulk foods
- Avoid overpackaged products
- Choose local products rather than imported goods
- Conserve energy
- Reuse materials when possible
- Repair items instead of replacing them
- Recycle materials that can't be reused
- Practice space efficiency
- Rent infrequently used items, instead of buying
- Share ownership of items like large or expensive tools or equipment with friends and neighbors

Organizations active in protecting natural resources (and sources of additional information)

National (some with local chapters)

Alliance for the Wild Rockies
Box 8731
Missoula, MT 59807
406-721-5420

Audubon Society
950 Third Ave.
New York, New York 10022
212-832-3200

Earth Island Institute
300 Broadway, Suite 28
San Francisco, CA 94133

Greenpeace USA
1436 U St., NW
Washington D.C. 20009
202-462-1177

National Wildlife Federation
1400 16th St. NW
Washington D.C. 20036-2266
202-797-6800

The Nature Conservancy
1815 N. Lynn St.
Arlington, VA 22209
703-841-5300

Rainforest Action Network
301 Broadway, Suite A
San Francisco, CA 94133
415-398-4404

Sierra Club
730 Polk St.
San Francisco, CA 94109
415-776-2211

Wilderness Society
1400 Eye St. NW
Washington D.C. 20036
202-883-2300

World Wildlife Fund
1250 24th St. NW
Washington D.C. 20037
202-293-4800

American Rivers
801 Pennsylvania, SE, Suite 303
Washington D.C. 20003
202-547-6900

Ducks Unlimited
1 Waterfowl Way
Long Grove, IL 60047
708-438-4300

Environmental Defense Fund
257 Park Ave. South
New York, New York 10010
212-505-2100

Institute for Local Self-Reliance
2425 18th St. NW
Washington, D.C. 20009
202-232-4108

Natural Resources Defense Council
40 W. 20th St.
New York, New York 10011
212-727-2700

PEER (Public Employees for Environmental Responsibility)
810 1st St. NE, Suite 680
Washington D.C. 20002

Sea Shepherd Conservation Society
Box 7000-S
Redondo Beach, CA 90277
213-373-6979

Union of Concerned Scientists
26 Church St.
Cambridge, MA 02238
617-547-5552

Woodworkers Alliance for Rainforest Protection
289 College St.
Burlington, VT 05401
802-862-4448

WorldWatch Institute
1776 Massachusetts Ave., NW
Washington, DC 20036
202-452-1999

Montana State or Regional Organizations

Alternative Energy Resources Organization
25 S. Ewing St., Suite 214
Helena, MT 59624
(406) 443-7272

Montana Environmental Information Center
P.O. Box 1184
Helena, MT 59624
(406) 443-2520

Montana Land Reliance
Helena, MT
(406) 443-7027

Montana Public Interest Research Group
University of Montana
Missoula, MT 59812

Northern Plains Resource Council

Governmental Agencies

Montana Department of Natural Resources
Montana Department of Health and Environmental Sciences

Local Contacts

Local chapters of environmental organizations.
Returned Peace Corps volunteers
City and county health departments

Environmental Education Resources

If you are interested in learning about more programs similar to Building Our Children's Future, or resources for other types of environmental education, contact one of the listed environmental education groups.

Center for Environmental Education
881 Alma Real Drive, Suite 300
Pacific Palisades, CA 90272
Phone 310-454-4585, Fax 310-454-9925
E-mail: cee@earthspirit.org

Montana Environmental Education Association
P.O. Box 8065
Bozeman, MT 59771

Building Our Children's Future
Building Material Design Contest

The object of this contest is to allow the student to create a building material made from a renewable, non-toxic, indigenous, reused and or recycled material or combination of materials. Have students choose the best material in each class and submit the winner to CRBT. CRBT staff will select a winner on May 1. The contest winner will receive a resource-efficient trophy and a copy of CRBT's Guide to Resource Efficient Building Elements.

Contest parameters:
The judging will consider issues from each building block, including:

- life cycle analysis of material-
  Resources used, transport of resources to and from manufacturing facility, energy intensity of manufacture, use of material and reusability/recyclability after use.
- availability of materials required for manufacture according to location
- ease of use
- material it replaces
- creativity

Requirements for entries will include:

- picture, drawing or example of new material
- a short description of the overall "resourcefulness" of the material. This should include the manufacture process and a life cycle analysis of the material.

Entries should be sent to:

CRBT
P.O. Box 100
Missoula, MT 59806

Please call CRBT at (406) 549-7678 if you have any questions.

Building Our Children's Future
Building Project Design Contest

The object of this contest is to allow the student to create a structure that best exemplifies the resourcefulness that they have learned in studying "Building Our Children's Future". Have students choose the best design in each class, then send that design to CRBT. Entires will be judged by CRBT staff and a winner will be selected on May 1. The contest winner will receive a resource-efficient trophy and the CRBT publication, ReCraft 90: The Construction of a Resource Efficient House.

Entries should include:
- site plans
- floor plans
- elevations
- a description of the materials use and basis for using that material
- any energy efficient attributes of the structure
- where the structure is located on the site and in the bio-region and how it is designed to fit into that region. The student may choose to have the structure build on an island in the Pacific, or in Iceland, but we hope not to see concrete block structures on the island or bamboo huts in Iceland.

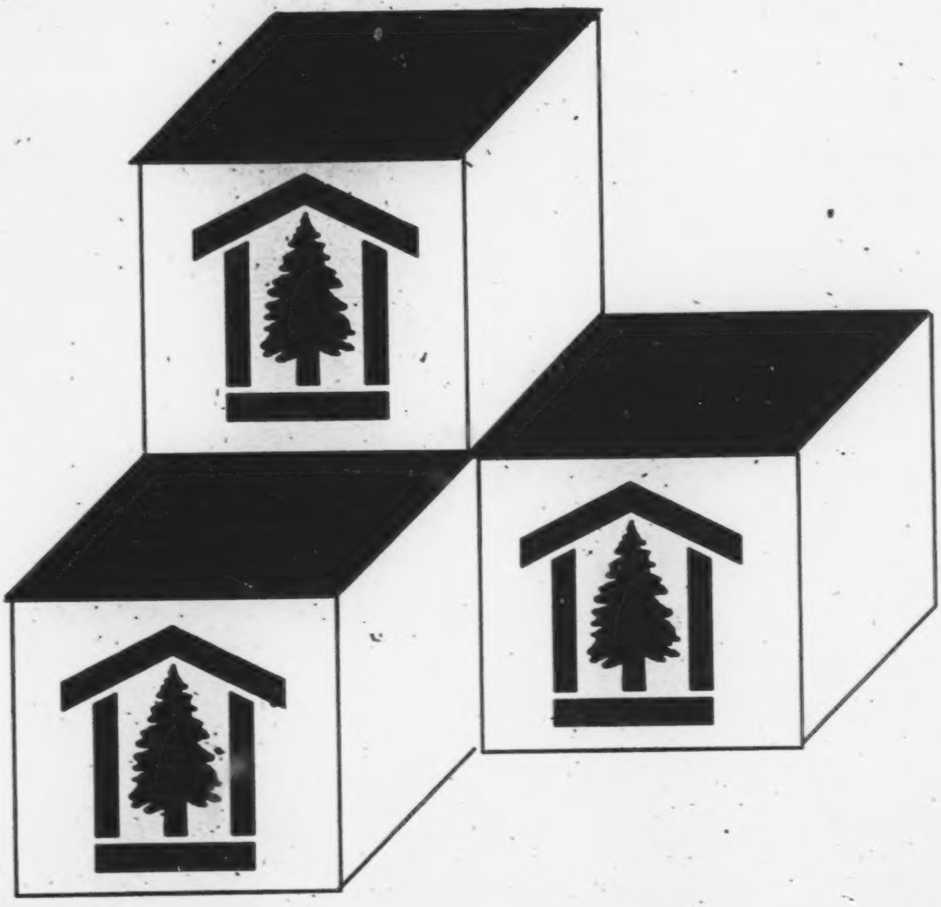
Entries can be sent to:

CRBT
615 Oak Street
P.O. Box 100
Missoula, MT 59806

Please call CRBT at (406) 549-7678 if you have any questions.

Building Our Children's Future

Learner Outcomes



Center for Resourceful Building Technology

Language Arts Learner Outcomes

Writing The learner:

Grades K-8

- Uses the writing process to create news stories, poems, essays and surveys.
- Becomes familiar with conservation vocabulary.

Grades 9-12

- Uses the writing process to create news stories, essays or poems, journal entries, surveys, presentations and plans, and research papers.
- Understands and uses conservation and design terms.

Reading The learner:

Grades K-8

- Reads paragraphs and short topic questions in order to participate in discussions about recycling, efficient housing, etc.

Grades 9-12

- Is introduced to the meaning of unfamiliar technical terms through the context of articles, texts, and papers on recycled building materials and conservation issues.
- Practices the research processes of locating sources and filtering information from a variety of formats, including archives, articles, books and the Internet.

Listening The learner:

Grades K-3

- Listens to articles, written descriptions and guest speakers.

Grades 4-12

- Invites guest speakers from other countries to speak to the class about how their housing, climate and natural resources differ from those in the United States.
- Participates in group discussion in an orderly manner, with respect for diverse opinions.
- Conducts interviews and comprehends messages from guest lecturers.

Speaking The learner:

Grades K-12

- Reads his or her writing aloud to an audience willing to listen to writing about reusing, recycling and efficient homes.
- Discusses topics presented with each lesson. Practices presenting facts and opinions persuasively.

Grades 9-12

- Gives speeches, oral readings, book reports and debates on topics dealing with housing and resource conservation.

Thinking Skills The learner:

Grades K-8

- Sees the relationships between natural resources and building materials, and connects these to relationships between reusing and recycling and individual and group actions.
- Applies thinking skills to develop creative solutions to environmental problems.

Grades 9-12

- Identifies and understands relationships between individual, national and global resource consumption, economics and environmental quality.
- Assesses environmental problems, creates solutions and plans for implementation of those solutions.

Mathematics Learner Outcomes

Mathematics as Problem Solving The learner:

Grade K-8

- Uses problem-solving approaches to investigate and understand the mathematical content of architectural design, recycling and reusing products, and building structures.
- Formulates problems from situations which arise in the building process.

Grades 9-12

- Develops and applies strategies to solve problems, with emphasis on multi-step and non-routine problems which threaten our environment.
- Verifies and interprets results with respect to the original problem situations.
- Generalizes solutions and strategies to new problem situations.
- Computes personal finances when determining the cost of using energy and resource efficient building materials vs. conventional materials.

Mathematics as Communication The learner:

Grade K-8

- Reflects upon and clarifies his or her own thinking about mathematical ideas and situations for design and building projects.
- Uses the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas.
- Discusses mathematical ideas and makes conjectures and convincing arguments.
- Works with others in small groups to solve problems.
- Interprets and uses graphs and numbers to convey results of data collection and problem solving.

Grades 9-12

- Reflects upon and clarifies his or her own thinking about mathematical ideas and situations for design and building projects.
- Uses the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas.
- Discusses mathematical ideas and makes conjectures and convincing arguments.
- Reads solar energy, energy efficiency, and other resource texts and supplementary materials that deal with the mathematics of design.
- Works with others in small groups to solve problems.
- Computes statistical analyses (mean, median, mode, upper and lower quartile range, interquartile range, outliers from a data sample) and makes visual displays (charts, graphs) of data.

Mathematics as Reasoning The learner:

Grade K-8

- Practices estimation and mental arithmetic skills.
- Gains experience in gathering data.
- Creates charts, graphs and tables that aid in comparison and decision making.

Grade 9-12

- Appreciates the pervasive use and power of reasoning as a part of mathematics.
- Practices estimation and mental arithmetic skills, particularly in conjunction with calculator use.
- Gains experience in gathering data and in analysis of data.
- Creates and interprets charts, graphs and tables.

Mathematics as Connections The learner:

Grade K-12

- Applies mathematical thinking and modeling to solve problems in resource efficient building.
- Values the role of mathematics in architecture, resource conservation, and building.
- Uses mathematics as a tool in understanding links between population and resource consumption.

Geometry and Spatial Sense The learner:

Grade K-4

- Makes and tests conjectures.
- Follows logical arguments.
- Draws and understands properties of lines, segments, and angles.
- Constructs parallel and perpendicular lines for the design of a building.
- Solves problems of measurement (perimeters, volumes, and area) related to building and the environment.

Grade 9-10

- Makes and tests conjectures.
- Formulates counter examples.
- Follows logical arguments.
- Judges the validity of arguments.
- Constructs simple valid arguments, draws these out, constructs plans and models.
- Draws and understands properties of lines, segments, and angles.
- Constructs parallel and perpendicular lines, plus equations for lines for the design of a building or site using a CAD program.
- Constructs figures and makes oral and written arguments to solve real problems of designing and building energy efficient housing.
- Solves problems of measurement (ratio of differences, proportions, perimeters, volumes, distance and area under variant and invariant conditions) related to building and the environment.

Science Learner Outcomes

Change The learner:

Grades K-12

- Becomes aware of how human activities alter natural ecosystems.

Grades 3-6

- Recognizes the effects of extreme weather and seismic events on the Earth's surface and the Earth's inhabitants, with particular emphasis on housing requirements with respect to these natural forces.

Grades 3-12

- Investigates building technology and discovers how the systems of our homes and buildings affect our lives.
- Connects natural resources with the materials and energy produced from them.
- Follows the life cycle of changes in materials, from extraction through recycling.

Grades 10-12

- Experiments with recombining materials to achieve greater strength and develops uses for waste products.

Equilibrium The learner:

Grades K-6

- Explores the components of habitats and ecosystems.

Grades 6-12

- Integrates habitats and conflicting uses.
- Identifies means of maintaining comfort by using natural processes to maintain homeostasis. Compares the mechanical systems of houses to natural heating and cooling strategies.
- Recognizes the effect of embodied energy in building materials.

Interrelationships The learner:

Grades K-12

- Understands the importance of conservation and preservation of natural resources and learns how to be a responsible consumer of natural resources.

Grades 1-6

- Discovers the ways living things are affected by environmental factors such as weather and climate, pollution, urbanization and availability of water and fuel.

Grades 4-8

- Discovers that like other living things, people must adapt to the conditions of their habitats. Recognizes the effects of regional climate, extreme weather and seismic events and availability of resources on housing styles and designs.

Grades 6-12

- Discovers the forces of nature which determine weather and climate and correlates these forces with human adaptation to regional conditions.
- Identifies the impacts of human housing trends and patterns on the natural environment. Appreciates the vital importance of conservation of natural resources and discovers methods of resource conservation and restoration.

Organization The learner:

Grade 1-12

- Discovers careers in building design and construction, rural and urban planning, and natural resource management.

Grades 2-8

- Correlates seasons and weather with energy use.

Grades 2-12

- Understands the applications of various units of measurement and applies that knowledge to problems concerning natural resources and housing.

Grades 5-12

- Becomes proficient at reading and interpreting maps for gathering climatic, topographic, land use and population information.

Grade 7-9

- Discovers the principles of design and structure.

Grades 9-12

- Compares the systems of buildings with the systems of the human body, and examines the structures of natural systems.

Time/Space The learner:

Grades 2-12

- Tracks processes of change in buildings, communities and regions over time, and identifies causes of change.
- Grasps the relationship between housing design and use of space.

Grades 7-12

- Investigates human population dynamics regionally and globally to understand the relationships between human population growth and depletion of natural resources.

Variation The learner:

Grades K-12
- Recognizes the difference between seasons, climates and bioregions, and the need for people living in each location and situation to adapt their housing to their situation.

Grades 5-12
- Explores the distribution of natural resources in different regions. Investigates the different applications of these various resources.

Grade 7
- Investigates differences between various climates around the world in terms of such physical factors as temperature, rainfall, sunlight and topography.

Energy/Matter The learner:

K-6
- Identifies practical uses for recycled materials.
- Redefines some "waste" as a usable resource.

Grade 1-8
- Examines the natural resources consumed in the construction and maintenance of buildings.

Grade 2
- Describes the sun and understands the applications of solar energy.

Grade 3-5
- Investigates various sources of energy including solar, wind, hydropower, fossil fuels, nuclear power, biomass and wood. Understands several forms of energy including light, heat, and electricity.

Grade 5-8
- Identifies renewable and nonrenewable resources and understands the difference between reusing and recycling materials.
- Relates the power used in homes and other buildings to the original energy source. Defines the pathway of energy from natural resource extraction to the light switch.
- Quantifies electrical consumption at school and at home in terms of watts, kilowatts and kilowatt hours.
- Investigates the applications of current and future technology to the conservation of energy and other natural resources, with particular emphasis on housing issues.

Grade 9-12
- Discovers the natural processes of the earth which create energy sources and realizes the environmental effects of extracting and using those energy sources.

Social Studies Learner Outcomes

Cultural Heritage The learner:

Grade 3

- Understands through the study of cities, that building customs in different cultures are unique.

Grades 9-12

- Explains why the study of facts and concepts is important in understanding the past and present building practices.
- Relate several historical events to contemporary issues of population and resource demand.
- Identifies different works and styles of world architecture and relates their importance to the development and application of environmentally sound building practices.

Global Perspective The learner:

Grade K-1

- Realizes that people are interdependent.

Grade 2-8

- Understands that people from many countries can be friends and learn from one another.

Grade 3

- Understands, through the use of satellite pictures and map centers that he or she can share information with other countries.

Grades 9-12

- Describes the interrelationships between environmental issues and his or her own life and community.
- Prioritizes issues of concern for national and international survival.
- Offers alternative scenarios for possible local, national and international consequences of conventional building practices.

Tradition and Change The learner:

Grade K-1

- Identifies ways homes are alike and different.

Grade 2

- Explains how cities change over time.
- Gives examples of things people consider when choosing a new home.

Grade 3

- Realizes that historical buildings are important in understanding the past.
- Realizes that communities of long ago differ from communities today.
- Realizes that the culture in American cities changes over time.

Grade 4-12
- Recognizes the role of technology in discovering and developing new materials for use in construction.

Grade 6-8
- Identifies how societal trends and technology drive resource consumption.

Political/Economic The learner:
Grade 2
- Knows what a consumer is.
- Understands that communities are dependent on each other for resources and goods.

Grade 4
- Understands that people fill their basic needs in different ways according to where they live.
- Explains why we must use resources wisely.
- Distinguishes between renewable and non-renewable resources, and between raw materials and manufactured products.
- Analyzes ways natural resources are used and protected.
- Distinguishes between conservation and preservation.

Grade 5
- Analyzes the relationship between natural resources and economic activity.

Grades 9-12
- Explains building and population problems in terms of conservative, liberal and radical solutions.
- Understands the process by which resources are transformed into marketable goods, and the influences that affect market prices.

Social History The learner:
Grade 3-12
- Learns the vital role that individuals play, through their careers and actions, in the way people build and the way society uses resources.

Grade 4
- Understands that people fill their basic housing needs in different ways according to where they live.

Grades 9-12
- Appreciates cultural diversity based on historical concepts.

Spatial Relationships The learner:
Grade K-1
- Realizes the physical environment makes a difference in how people live and work.

Grade 2
- Describes different kinds of land and how people use them.
- Describes different kinds of weather.
- Understands that climate is the usual weather, varying from warm to cold, wet to dry.
- Explains why it is important to conserve resources and can give examples of ways to care for or preserve resources.

Grade 3
- Understands through the study of cities that customs in different cultures are unique.
- Identifies ways people use earth's resources, trees, water, coal and the sun.
- Defines, describe, and compare climates and environments throughout the world.
- Explains how a small area can serve many purposes.

Grade 6
- Analyzes characteristics of Earth's climates and how elevation, water and wind affect climate.
- Defines resource and explains when resources become valuable.

Grades 9-12
- Demonstrates a knowledge of the earth's physical environment and its influences on the development of building shelter.
- Analyzes the factors of the natural environment and man's ability to alter them in a positive or negative way.
- Analyze current environmental problems and examine the roles of individuals, societal agents and technology on developing and effecting solutions.
- Realizes cause and effect relationships in geographical processes.
- Analyzes how the relative location of a place provides important advantages and disadvantages for building homes.

Social Contracts The learner:

Grade 2
- Summarizes and explains how people and their environment interact.

Grade 6
- Understands that most societies are made up of a variety of groups that create changes within those societies.

Grade 6-12
- Realizes the importance of individual involvement in determining how a society relates to the environment.
- Recognizes that community members work together to conduct land use planning and choose energy sources.
- Understands that the structure of a community influences the way people use resources.

Grade 9-12
- Analyzes economic and environmental concerns and explores solutions.

Visual Arts Learner Outcomes

Aesthetic Perception The learner:

Grade K-8

- Has guided experiences that use the senses raise interest in the environment.
- Describes ideas and feelings when perceiving the sensory qualities in works of art, nature and the built environment.
- Recognizes design elements (line, color/values, shape/form, texture and space) in forms that are natural or human made.
- Observes the underlying principles of design structure, balance/unity, rhythm/movement, emphasis, contrast, repetition and variation.
- Relates design elements and principles to making buildings or environmental art.

Grades 9-12

- Recognizes the design elements (line, color/values, shape/form, texture and space) in forms that are natural or human made.
- Observes the underlying principles of design structure, rhythm/movement, balance/unity, emphasis, contrast, repetition and variation.
- Relates design elements and composition to making buildings or environmental art.

Careers The learner:

Grades 9-12

- Is introduced to careers in the areas of fine arts and architecture, crafts, graphics, teaching, and design, and meets with professionals to talk about possible careers in art.
- Hears lectures and sees work done by architects, artists, environmental artists and designers.
- Visits artists' studios, workshops, design offices and building sites.

Making Art The learner:

Grade K-12

Creativity

- Becomes aware of a great range of ways to express an idea or feeling related to the natural environment.
- Sees multiple solutions to a problem.
- Is aware that ideas can be expressed in a variety of media.

Personal Expression

- Identifies his or her feelings and uses them to respond to our indoor and outdoor environment with various media.

Basic Skills

- Uses elements and principles of design in a variety of media.
- Uses symbolic and observational drawing techniques.
- Uses water color, tempera, and oil painting techniques.
- Explores sculptural and ceramic techniques.
- Uses collage, metal, fiber, clay and paper making techniques to present ideas.
- Is aware of and uses film, video and photography techniques.

- Creates, uses and interprets maps as geographical representations.
- Uses recycled materials to create new works of art.
- Gathers and reuses materials to make art.
- Experiments with techniques and media for personal expression.

Architectural Production and Design
- Designs architecture in his or her environment using drafting and computer drafting techniques.
- Recognizes elements in the environment.
- Identifies the different parts of different building structures.
- Uses a variety of materials to create a dimensional building or other structure.
- Designs and creates indoor and outdoor environments.

Valuing The learner:
Grade K-12
Analysis
- Discusses art work with a visual arts vocabulary.

Interpretation
- Describes the meaning of a work of art using art vocabulary.
- Interprets meaning in terms of the historical period.
- Interprets architecture in terms of the culture, environment and climate which created it.

Judgment
- Understands that art works can have a value separate from his or her personal likes and dislikes.
- Realizes how society places judgment and value on works of art.
- Knows that professional artists and art critiques have different criteria for judging artwork.

Visual Heritage The learner:
Grade K-12
- Is exposed to art forms from a variety of world cultures.
- Notices chronological periods and styles of architecture.
- Explores his or her own built environment and traces its design history.
- Recognizes that cultures have their own style and symbols.
- Is acquainted with works done by environmental artists and of environmental themes.
- Looks at themes used in artwork throughout history and from this basis develops his or her own artwork.
- Relates environmental art experiences to other curriculum areas.

Building Our Children's Future – Evaluation

Please complete this application form and mail or fax it to: CRBT, PO Box 100, Missoula, MT 59806; FAX (406) 549-4100.

Your comments will help shape future editions of the Building Our Children's Future program. CRBT will continue to update and expand this program. Please include your address to ensure that you receive future topics and activities. Thank you for your valuable input.

Name ______________________

Address ______________________
____
____

Phone ______________________

Grade Levels Taught ______________________

Subjects Taught
____
____

# of students involved in the activities
____

Did this curriculum succeed in encouraging team teaching or interdisciplinary work?

Do your students have a better awareness of recycling _______, reusing resources _______, energy and resource conservation _______ as a result of the activities included in this curriculum?

Please suggest any ideas you or your students have for additional activities or topics to include in Building Our Children's Future. We will credit your class and school in subsequent editions.

Please suggest ideas for improvement of this curriculum package.

Which block did you most enjoy teaching? Why? Grade Level?

Which block did students most enjoy? What were some of their reactions to the material?